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Materials & Methods

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FEATURE ARTICLES

MATERIALS & METHODS MANUAL NO. 73

ENGINEERING FILE FACTS

DEPARTMENTS

NEXT MONTH: Tin and Tungsten . . . . Savings with Expanded Metal . . . . Low Hydrogen Welding Rods . . . . Rare Earths in Aluminum Baths Give Attractive Hot-Dip Coatings . . . . Fibreglas Easily Molded with Plastic Binder . . . . Steel Comparisons by the Notched Bar Test . . . . PHOSPHOR BRONZE (Materials & Methods Manual No. 74)

The Materials Outlook

Peace in Korea will bring looser controls all along the line—except in materials. There will be no letup in the Controlled Materials Plan even if the U. N. can buy peace in Asia. Critical materials will be required in increasing amounts for defense even in a watered down armament effort. . . . By early next year the picture will be brighter. We will then have ample steel-making capacity and a five-year stockpile of natural rubber, with synthetic supply sufficient for 95% of normal demand. Aluminum, magnesium, copper, lead and zinc will be in adequate supply. The headaches in tin, cobalt and nickel are here for some time to come, though. By the middle of 1952 chemical production should be increased enough to ease most of the major plastic shortages. . . . If the Russians push in Europe or the Near East this fall, all predictions are off.

There are still weak spots in the pattern. Tungsten supplies this year will fall 2 million lb short of the nation's needs for commercial purposes alone. This prospect is raised by a report by the Senate Armed Services watchdog subcommittee. The senators place the blame on poor liaison between Army requirements experts and Munitions Board stockpilers.

There are other straws in the wind showing the permanence of government and even international control of materials supplies. The 11-nation (minus Russia and satellites) International Materials Conference has announced the first world-wide agreement between users and producers of tungsten and molybdenum as to the allocation of those metals. . . . The U. S. gets the big bite of each. . . . With tungsten the conference went further, and set maximum and minimum prices. Other allocation agreements are being worked out for copper, zinc, lead, manganese, nickel and cobalt. That this will mean better metal supplies for American manufacturers is debatable. The reverse is more probable in an all-out war. . . . The U. S. Defense Minerals Administration has announced that it has launched a prospecting campaign in 14 Western states. Contracts have been signed for exploration projects for copper, manganese, asbestos, tungsten, zinc, lead, cobalt and nickel. This program should ease our dependence on overseas sources for these materials in years to come.

The defense program is bound to leave some fundamental changes in the American materials engineering pattern. . . . The recent emphasis on boron steels is a significant sign post. Whatever happens to the overall steel supply situation, the older rich alloys will remain a pleasant memory. The rich alloys are foolproof to heat treat and were often used unnecessarily. From now on better techniques, better equipment and better design are man-

(Continued on page 4)

The Materials Outlook *(continued)*

datory. The burden will be on the materials engineer to squeeze the last drop of usefulness out of less critical materials—like the lean boron steels. . . . This may be a good thing in the long run. Progress too often waits for a push from necessity. . . . Hot and cold extrusion of steel are other defense babies that are here to stay. . . . The tin situation has given impetus to the development of phosphate coatings for steel in cans. Commercial applications may not be too far away.

The high prices and exposed supply routes of natural rubber from the Far East have pushed important technical advances in synthetic rubber. . . . A process to make cold synthetic rubber latex will cut the requirements for the natural product. . . . Another important process that has emerged from a tangle of patents and politics is a method of mixing cheap petroleum with tough—once unusable—synthetic rubber waste to soften it up for processing in the usual manner. This is expected to stretch the synthetic output by 22%, without expanded plant capacity or raw material consumption.

Glass has been a sleeper in the engineering materials field. . . . Flexible glass ribbons have been developed as an alternate fr critically short mica in electrical apparatus, and electrically conductive glass is finding new applications. . . . Centrifugally cast glass has interesting possibilities in large glass cylinders, tank liners and large electronic tubes. . . . A process for chemically "machining" glass is still experimental. The glass is impregnated with photographic chemicals and exposed to ultra-violet light through a pattern. The glass is changed chemically by the light and a subsequent acid bath eats away the pattern shaded part, leaving the rest. A similar photographic process is being used to make artificial marble.

Plastics continue to be in great demand by the military. . . . Polyethylene, for instance, is being taken up largely by the military and essential civilian uses, and the uncontrolled supply has decreased to a trickle. The NPA promises that adjustments will be made in the share going to essential applications and that some items will be shifted into the free classification, where the supplier rather than the government decides how much each user gets. . . . For most plastics, though, there will not be enough to go around for the rest of this year anyway. Civilian requests for polyethylene in June were three times the available free supply.

The big stopper in plastics is the shortage of raw materials. . . . In vinyls, the bottleneck until now has been the resin production, but this may be remedied by new facilities. If resin supply picks up, a new limiting factor will probably be met in a shortage of plasticizer due to decreasing imports of raw materials. . . . Paints are competitors for the same raw materials as the plastics, and the military is traditionally greedy for paints. The alkyd paints will go in increasing quantities to defense, drawing the strings tighter around the plastics. . . . With the melamines the holdup is in production facilities. By the end of the year this should be remedied. . . . The consensus of opinion is that the production situation should iron out by early 1952, and plastics supply will begin to approach demand by then.

See page 7 for "Materials Control Orders"

Materials Control Orders

A summary highlighting actions of the NPA affecting engineering materials during the period from June 16, 1951 through July 15, 1951.

CONTROLLED MATERIALS PLAN

Dir. 3 to Reg. 1—Prime consumers prohibited from ordering a quantity of a controlled material for any one month's consumption in excess of 35% of that authorized in their quarterly allotment.

Dir. 1 to Reg. 1, Amended—Permits small users of steel, copper and aluminum to obtain allotments of these critical materials in specified quantities for their quarterly use.

Reg. 3, Amended—Manufacturers and others receiving authorized production schedules and related allotments of controlled materials may not purchase additional materials of any kind to augment their output of items for which allotments have been made.

Dir. 2 to Reg. 3—DO ratings previously assigned defense-supporting construction industries and other important programs for acquisition of materials are given equal status with authorized controlled materials orders during the third quarter.

Reg. 6—Sets up procedures for obtaining permission to proceed with construction projects and to get the necessary materials. Sets forth maximum quantities of controlled materials that may be obtained for construction without requiring authorization.

ALUMINUM (Orders M-5, M-7, M-47A, M-68)

Present Status: As of July 1, end product producers' use of aluminum came under M-47A or CMP. CMP supersedes M-47A in cases of conflict. During third quarter, products on List A limited to 50% of aluminum consumed during January through June, 1950; products on List B limited to 75% of consumption during first quarter of 1951. Restrictions on non-operational use of aluminum in items covered relaxed but use of aluminum for decorative purposes remains prohibited. Use of aluminum castings and forgings in automobiles is now restricted by M-68 rather than M-7.

Anticipated Changes: Proposed order specifies quantities of aluminum which may be used for construction without requiring allocations. Will replace M-4 when that order is revoked.

COPPER (Orders M-4, M-11, M-12, M-16, M-47A, M-74)

Present Status: Starting July 1, end-use limitations on copper are transferred from M-12 to M-47A. Products in List A of new order are permitted to consume copper up to 60% of quantity they required during January to June, 1950. Those in List B permitted to consume 80% of that during first quarter of 1951. Limitations on non-operational use of copper in some listed items are relaxed, but use for ornamental purposes is still forbidden. During third quarter, producers of brass mill products must reserve specified percentages of their scheduled monthly production of items listed in M-11. Producers must accept 80% of scheduled monthly production in DO or ACM (authorized controlled materials) orders. Foundry operators must accept 90% of scheduled monthly production of beryllium copper castings in rated orders, 75% for all other castings. Seventy-five percent of overall production must be reserved for rated orders. Such orders may be rejected by producers, sellers or owners of unalloyed copper unless orders are specifically permitted by the NPA. Use of copper or copper-base alloys in manufacture of certain building materials fabricated off the site of construction is prohibited.

Anticipated Changes: Copper raw materials, including refined copper, copper and copper-base alloys and copper scrap, under complete allocation. Use of minimum amounts of copper for construction without allocations may be permitted.

IRON AND STEEL (Orders M-1, M-6, M-47A)

Present Status: End producers' use of steel now limited by M-47A or CMP, CMP to supersede in cases of conflict. Iron and steel for products under List A of M-47A may be used in quantities up to 70% of those used during January to June, 1950 for the same purposes; for products under List B, up to 85% of permitted use during the first quarter of 1951. Items not previously controlled under M-47 include sewing machines; medical, dental and hospital specialties; garbage and ash cans; razors and blades; electric shavers; soldering irons; incandescent hand portable lighting equipment; and baby carriages. Producers of carbon steel products must set aside percentages of their planned monthly production, starting in September, to fill rated orders and minimum allotments required to be made by producers to converters and distributors. Set-aside reserves for rated orders for alloy steel products have been increased for the third quarter to such percentages as: 50% for ingots; 65% for blooms, slabs and billets; 85% for tube rounds; and 75% for universal mill plates.

Anticipated Changes: Permission to use minimum amounts of steel for construction without requirement of allocations.

NICKEL (Order M-14)

Limitations on use of primary nickel extended through the third quarter at 65% of average quarterly use during first six months of 1950.

RUBBER (Order M-2)

Starting July 1, use of high tenacity rayon for tire manufacture restricted to average quarterly use during first six months of 1951.

TIN (Orders M-8, M-25)

Starting July 1, no packer may purchase or use cans of any type for purposes other than those listed in Schedule I of M-25. Cans for products designated in preference B may not be supplied until all deliveries for products designated in preference A are met. Production of cans for such products as beer, pet foods, motor oil, some paints, fruitades and some fish and poultry products has been cut to 70% of amount used during corresponding quarter of either 1949 or 1950. Pig tin users still permitted 90% of amount used during first six months of 1950 but without permission to obtain additional tin for war uses, as previously. Size of purchases exempt from allocations is reduced from 5 long tons to 6000 lb. Inventories now limited to 45-day supply. Milk can and tin plate manufacturers are removed from 90% limitation, as they have been fully programmed. Specifications have been established for wrought bronze alloys. Tin content has been reduced to 50% in solder for electrical precision instruments, recording and indicating meters, dairy equipment, food processing equipment and sterilizing equipment.

TUNGSTEN

Expanded defense requirements for high grade tungsten ores in the coming months are expected to cut allotments to other programs. A cut, not in excess of 10%, may be applied to tungsten for the carbon tool industry.

ZINC (Order M-9)

As of Aug. 1, slab zinc (including all grades of metallic slab zinc produced by electrolytic, electrothermic or fire refining processes) is under complete allocation. Deliveries for GSA for stockpiling, acceptance from a foreign source for resale without change in form, and certain small consumers are exempt.

News Digest

NPA Reports on Materials Shortages

The National Production Authority has issued a 4-page list of basic materials and alternates to guide manufacturers and designers in procurement and substitutions for products. The list reviews 550 materials and groups them according to three degrees of availability—(1) very short, (2) tight, and (3) in fair supply.

Alternates should be selected for all the materials in very short supply whenever possible. Expanded use of the materials listed as tight should be avoided by industry. The materials in fair supply should be substituted for those that come under the other two headings where this is feasible.

Some of the major materials groupings are:

Metals—Very short: aluminum, lead, copper, tin, zinc, nickel, tungsten, and a number of forms of steel, including tinplate, heavy forgings, high alloy castings, die blocks, wire, sheet, nickel-bearing stainless steel, structural shapes, seamless and welded tubing. In tight supply: vanadium, chromium, manganese, carbon steel, hot rolled bars, black sheet, plate, other stainless steel. Fair supply: titanium, carbon steel and gray iron castings, forgings and tool steel.

Plastics—Very short: ethyl cellulose, nylon, polyvinyl acetate, phenolic resins, polyethylene, polytetrafluor ethylene, resorcinol resins. In tight supply: alkyds, cellophane, cellulose buyrate, melamine, methacrylate, pliofilm, polyesters, polystyrene, polyvinyl butyrol, polyvinylidene chloride, urea resins. In fair supply: cellulose acetate, vinyl chloride.

Miscellaneous—Very short supply: corundum, graphite, industrial diamonds, mica, most types of new rubber. Tight supply: fluospar, paper and paper board. Fair supply: reclaimed rubber.

The materials classifications were determined in collaboration with: (1) the Industrial Economics Div. of the Policy Coordination Bureau and the various Materials Divisions of the National Production Authority; and (2) the Office of Materials Resources of the Munitions Board.

Copies of the list may be obtained from the Dept. of Commerce, National Production Authority, Salvage and Reclamation Div., Washington, D. C., or from regional offices of the NPA. Revisions will be issued periodically to reflect changes in the availability situation.

Laboratory Research on Materials Reported by NACA

The National Advisory Committee for Aeronautics recently issued several interesting reports summarizing research projects carried on by government and private laboratories on engineering materials. Bound copies of these Technical Notes are available from the NACA, Washington, D. C.

Technical Note 2377, "The Effect of Fuel Immersion on Laminated Plastics," by W. A. Crouse, Margie Carickhoff and Margaret A. Fisher covers work done at the National Bureau of Standards. The effects of cyclic and continuous immersion in heptane, toluene and SR-6, a test fuel, on the weight, dimensions and flexural properties of 19 samples of laminated plastics were determined. No one sample exhibited smaller changes than all other samples for all fuels and for both cyclic and continuous immersion. The best weight and dimensional stability in the cyclic test was shown by a glass-fabric unsaturated-polyester laminate. The changes in flexural strength as well as in flexural modulus of elasticity were losses in the majority of cases after both the cyclic and continuous immersion tests. The unsaturated-polyester laminates varied widely among themselves in regard to the magnitude of the change in a given property after an immersion test.

D. N. Frey, J. W. Freeman and A. E. White of the University of Michigan are the authors of Technical Note 2385, "Fundamental Aging Effects Influencing High-Temperature Properties of Solution-Treated Inconel X". Studies were made of the mechanisms by which various aging treatment influenced the mechanical properties of solution-treated Inconel X alloy. Microstructure analyses at the various aged conditions were made by means of x-ray diffraction studies and optical- and electron-micrographic examinations. Correlations of the mechanical properties with the structural analyses and comparisons with the previously determined aging effects on low-carbon N-155 alloy are presented.

Technical Note 2386, "Studies of High-Temperature Protection of a Titanium-Carbide Ceramal by Chromium-Type Ceramic-Metal Coatings", is by Dwight G. Moore, Stanley G. Benner and William N. Harrison of the National Bureau of Standards. Four ceramic-metal coatings of varying frit content were prepared and applied to ceramals containing 80 chromium and 20% cobalt. Oxidation penetration, transverse breaking load, and thermal shock resistance of the various specimens were determined after prolonged heating in air at temperatures of 1650, 1800, 2000 and 2200 F. The effects of varying firing time, firing temperature, and number of coats applied were studied for one coating.

Technical Note 2389, "Fatigue Strengths of Aircraft Materials", by H. J. Grover, S. M. Bishop and L. R. Jackson of Battelle Memorial Institute, presents results of axial-load

(Continued on page 10)

News Digest

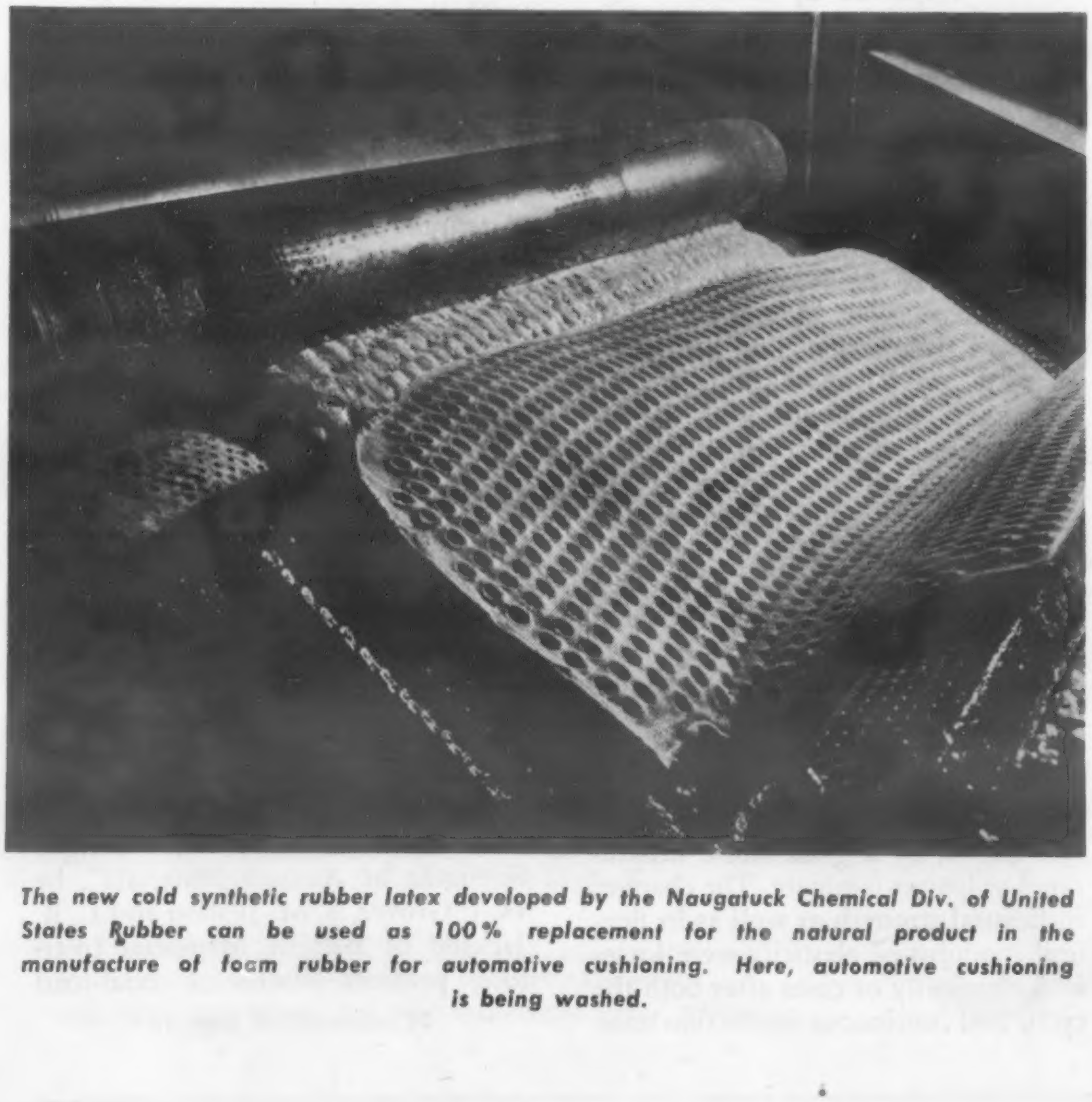
fatigue tests on notched specimens of 24S-T3 and 75S-T6 aluminum alloys and normalized SAE 4130 steel with stress-concentration factors of 2.0 (central circular hole, symmetrical edge notches and fillets) and 4.0 (symmetrical edge notches and fillets). Fatigue tests were run at several levels of nominal mean stress. Results are compared with previous data for unnotched specimens.

The last report, Technical Note 2397, "The Influence of Tensile Strength and Ductility on the Strengths of Rotating Disks in the Presence of Materials and Fabrication Defects of Several Types", covers work done by Arthur G. Homes, Joseph E. Jenkins and Andrew J. Repko at the Lewis Flight Propulsion Laboratory. The influence of tensile strength and ductility on disk strength was investigated with material and fabrication defects present. In two cases, an optimum compromise between tensile strength and ductility occurred at a ductility less than 15% elongation. In a third case, no influence of ductility was observed. When compared with performance previously observed for disks not containing irregularities, losses in disk strength for the defects investigated varied from 23 to 58%.

New Cold Synthetic Rubber Latex Saves Natural Rubber

The development of cold synthetic rubber latex, the first synthetic latex to approach natural rubber latex in service and wearing quality, has been announced by the Naugatuck Chemical Div. of the United States Rubber Co. The development is a major step toward complete independence of the United States from natural rubber supplies in the Far East, according to John P. Coe, vice president and general manager of the division.

Latex is minute particles of rubber suspended in water. The new cold synthetic latex polymerizes at about 50 F and gives a more regular structure, and hence a stronger final product, than the varieties of synthetic latex used up until now which were processed at a higher temperature.



The new cold synthetic rubber latex developed by the Naugatuck Chemical Div. of United States Rubber can be used as 100% replacement for the natural product in the manufacture of foam rubber for automotive cushioning. Here, automotive cushioning is being washed.

The lack of a practical, high quality synthetic rubber latex which could be used as an alternate material for the natural product has been a major bottleneck since commercial production of synthetic rubber started ten years ago. The types available up until now usually required a relatively large percentage of added natural rubber to bind the synthetic and give the product strength. The need for a better synthetic latex has grown even more acute with the sharp rise in natural rubber prices since the start of the Korean War.

Many types of synthetic rubber latex have been produced experimentally, but the new cold varieties are the first of the GR-S or general purpose type, and promise to compete with natural rubber latex in large volume applications in the rubber industry. The new latex can be used 100% or with smaller percentages of natural rubber reinforcement than were formerly practical. This is possible because of the increased strength of the more regular structure of the cold synthetic latex.

Actually, there is no one all-purpose type. Seven varieties of cold rubber latex have already been developed. As research progresses, many more will undoubtedly be possible. This means that synthetic latex can be tailor-made for specific applications. This versatility has not been possible with natural latex.

For example, one variety of cold latex can be used as a 100% replacement for the natural product in the manufacture of foam sponge for furniture cushioning and automotive upholstery. Still others show promise as replacements for natural latex in the manufacture of tires containing rayon tire cord, in several dipping processes, in the manufacture of sheet packing materials and brake linings.

Cold synthetic rubber latex was developed by a team of research scientists at the Naugatuck, Conn., synthetic rubber plant operated by Naugatuck Chemical for the Reconstruction Finance Corp. It is the result of more than five years of research and two years of experimental pilot plant production and product evaluation.

Demand for cold latex is high throughout the rubber industry although production is still limited. The current cold rubber expansion program inaugurated by the RFC in government-owned plants will make increasing quantities of cold latex available to the industry, however.

News Digest

New Devices Speed Metal Fatigue Tests

Several devices recently constructed at the National Bureau of Standards are proving valuable in speeding metal fatigue tests in the NBS mechanical metallurgy laboratory. Developed by John A. Bennett and James L. Baker of the NBS staff, the new auxiliary test equipment includes devices for stopping the testing machine when a small crack forms in a specimen, apparatus for the uniform polishing of fatigue test specimens, and a machine for fatigue-testing thin sheet specimens in bending.

Devices for Stopping the Testing Machine

One commonly-used fatigue-testing machine applies a bending moment to the specimen, simultaneously rotating it so that every point on its surface is subjected to a cycle which goes from tension to compression during each revolution. Mounted on standard commercial testing machines, the two NBS stopping devices respond to changes in the stiffness of the specimen when a small crack forms.

In a typical testing machine the specimen of 0.25-in. minimum dia is drawn into spindles in bearing boxes. The bearing boxes are supported at the ends away from the specimen and loaded at the ends near the specimen by weights hung on shackles. This loading results in a deflection of the bearing boxes, and the deflection increases when a crack forms in the specimen. If the crack is only on one side of the specimen, the deflection will vary periodically with each revolution of the specimen; in other words, the bearing box will vibrate. Both the deflection and the vibration are used to actuate the NBS stopping devices; one device is deflection-responsive and the other is vibration-responsive. The two stopping devices are used simultaneously at NBS, with their circuits connected in parallel; sometimes one will respond first, sometimes the other, depending on the peculiarities of the particular incipient crack.

The NBS deflection-responsive stopping device consists of a microswitch operated by a lever. The lever is fastened rigidly to one of the bearing boxes, and at the other end carries an adjusting screw which bears on the actuating leaf of the microswitch. After the machine has run long enough to reach temperature equilibrium, the adjusting screw is advanced until a very small change in the position of the lever will trip the microswitch and shut off the machine. With careful adjustment, the arrangement is sensitive to cracks having a length of as little as 5 to 10% of the circumference of the specimen.

The vibration-responsive stopping device, which is fastened rigidly to one of the bearing boxes, consists of a steel ball poised on a three-pronged pedestal. Vibration resulting from an incipient crack in one side of the specimen shakes the ball from its perch; in falling, the ball closes an electrical circuit that shuts off the machine. Sensitivity of the device may be adjusted by varying the distances of the pedestal prongs from each other.

Apparatus for Polishing Fatigue Test Specimens

The surface condition of test specimens has an important effect on fatigue and must, therefore, be made as uniform as possible. Two pieces of apparatus developed at the Bureau, both entirely automatic, make possible close duplication of the polishing operation from one specimen to the next.

In finishing specimens it is important that the direction of polishing be parallel to the direction of the stress to be applied in the fatigue test. This avoids stress concentration at the roots of the scratches. It is also important that abrasive pressure be light in order to avoid excessive cold-working of the surface. If these requirements are met, the surface need not be extremely smooth or highly polished.

The machine for finishing smooth specimens consists essentially of three parts: a wheel carrying an abrasive belt, a means for supporting and rotating the specimen during the polishing operation, and a means for moving the specimen across the abrasive belt during polishing.

The wheel is distinctive in consisting of a large number of metal spring leaves, radiating outward from a hub, which press against the abrasive belt. This arrangement conforms the abra-

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sive belt to the contour of the specimen and assures uniform abrasive pressure. The specimen is rotated at a rate which bears a constant relation (1 to 100) to the rotation of the abrasive wheel. Because the specimen is moved slowly across the abrasive belt, fresh abrasive is continually brought into use, resulting in a cutting rather than a rubbing action. A rubbing action is to be avoided, since it tends to produce more cold work in the specimen surface.

The apparatus for finishing notched specimens is new only in a few details. It consists essentially of an abrasive-charged wire which rotates against the bottom of the notch while the specimen is slowly rotated.

The specimen is held in a small bench lathe. A series motor, mounted on a cross-feed guide with its axis of rotation perpendicular to the axis of the specimen, drives the polishing wire through a short rubber coupling. A guide for the polishing wire is supported by a pivoted assembly above the working area, so that the weight of the guide holds the wire against the specimen. The abrasive, a thin air-agitated mixture of emery and water, is fed to the wire from a reservoir through a valve-controlled tube.

The motor that drives the polishing wire also drives the headstock of the lathe through a 100-to-1 reducing gear. By keeping motor speed and polishing time constant, as well as the ratio of wire speed to specimen speed, high uniformity of finish is assured. Moreover, the finish is very similar to that produced by the machine for finishing smooth specimens.

Fatigue Testing Machine for Thin Sheet Specimens

Because of the large deflection required, sheet metal of less than about 0.015-in. thickness cannot be fatigue-tested in bending on commercially available testing machines of the cantilever type. By deflecting the specimen as a column, a newly-developed NBS fatigue-testing machine makes possible the bending of specimens to a small radius of curvature without large amplitudes of motion in the driving mechanism. Because the machine holds several specimens at once, considerable testing time can be saved.

The new thin sheet fatigue tester

(Continued on page 140)

The Role of Boron Steels in the Present Emergency

by P. R. WRAY, Metallurgical Engineer, United States Steel Co.

The boron steels, the most promising alternate materials for scarce high-alloy heat treating steels, must be used correctly to take full advantage of their potentialities.

● THE REARMAMENT PROGRAM has created a critical shortage of several alloying elements for the standard alloy steels. Cobalt, columbium, tungsten, nickel and molybdenum are in the critical category already, while chromium and manganese may come into the same class as time goes on. At the moment, there is practically no cobalt, columbium and tungsten, and less than half enough nickel and molybdenum to produce the standard alloy steels containing these elements for other than military applications. The alloy shortage is worse now than in World War II because: (1) we were forced to use the best ores during that emergency and are now mining lower grade deposits; (2) the United States is now producing 30% more steel; and (3) military equipment today requires richer alloys.

The seriousness of the critical alloy problem and the return of government controls to bring steel alloy supply and demand into balance are forcing us to make plans for the future. If the war spreads, the military appetite for alloy steels may leave little or none for other uses. The one ray of hope, at least as far as heat treating steels are concerned, is the potential of the element boron for increasing the hardenability of steel.

In most applications of constructional alloy steels, boron can replace a sizable quantity of nickel, chromium, molybdenum and other critical elements. In addition to conserving alloy elements, however, boron has other advantages. It improves the hot and cold working properties of the steel, gives a shorter annealing cycle, and imparts better machinability. When boron is used as an alloy replacement in carburizing steels, the treatment is simplified by the shorter annealing cycle, and the retained austenite and undissolved carbides in the carburized case are minimized.

In some applications which require medium or high carbon steels too, a boron steel can replace a richer alloy with considerable savings, not only in steel cost, but in fabrication. In the last part of World War II, thousands of tons of boron steels were used in military equipment—in armor, projectiles and torsion springs for tanks, for instance. Since 1945, large production applications for boron steels have been found in diesel locomotive crankshafts, heavy duty tractor axles, wrenches and cold headed parts.

Effects of Boron in Steel

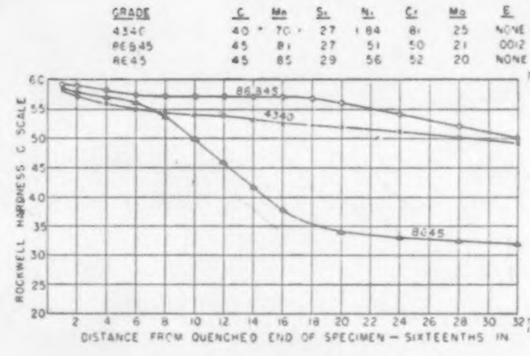
The Metals Handbook of the American Society for Metals describes the role of boron in steel as follows: "Boron is used in steel for one purpose only—to increase the hardenability; that is, to increase the depth to which the steel will harden when quenched. Only a few thousandths of a percent is ordinarily added."

The effect of boron on hardenability is very potent. It can replace several hundred times its own weight of manganese, chromium, molybdenum and nickel. In 8645-plus-boron steel, for example, 0.001% boron gives the same hardening effect as 1.33 nickel, plus 0.31 chromium, plus 0.04% molybdenum — a total of 1.68% alloy.

This effect of boron on hardenability decreases with increasing carbon content, however, and boron is most effective in conserving critical alloys in the low carbon steels. The carburizing grades of alloy steel, with less than 0.30% carbon, are more fertile fields for boron substitution than spring steels at 0.60% carbon.

Isothermal transformation diagrams are helpful in understanding the behavior of boron steels during conventional quenching, normalizing and annealing heat treatments. If the time for the beginning of transformation

Small quantities of boron can replace significant amounts of critical alloying elements in heat treating steels.

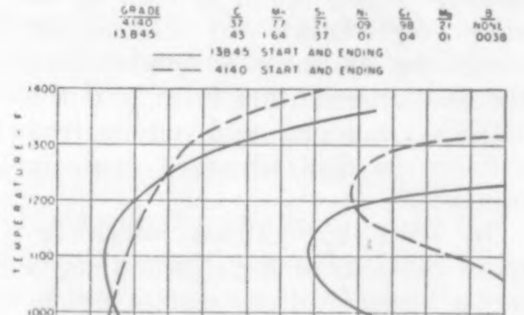


Typical end-quench hardenability curves of 8645, 8645-plus-boron (86B45), and 4340 show the potent effect that boron has on hardenability.

at the nose of the curve is approximately the same for a given boron steel and a higher alloy steel (*i.e.*, they have equivalent hardenability), the time required to complete the transformation will be much shorter for the boron than for the high alloy. As a matter of fact, the completion time for a boron steel is only slightly longer than it is for the same steel minus the boron. In this respect boron is unique. It delays the start of transformation appreciably but delays completion only slightly.

This has practical significance, since a low alloy boron, used to replace a higher alloy and give the same properties when hardened, can be annealed with a much shorter cycle than the original high alloy steel. The boron steel is also much softer in the as-rolled or normalized state, provided that the piece is large enough to prevent air quenching.

In spite of the fact that boron has such a powerful effect on hardenability, it makes almost no change in the Ae_1, Ae_2 or M_s temperatures of the base composition.



Comparison of the isothermal transformation diagrams of 1345-plus-boron (13B45) and 4140 show that boron retards the beginning of transformation but has little effect on the time required for completion.

Properties of Boron Steels

Boron tends to lower the austenite coarsening temperature of a steel. This effect can be counteracted by a judicious increase in the aluminum addition used for grain size control, however.

The exact effect of boron on notch toughness is not clear. Comparison of a given composition with and without boron indicates that the addition increases notch toughness at high hardness levels (R_c50 and above) and reduces it at lower hardness. When a low alloy boron composition is compared with a higher alloy steel, however, the effect of the boron on the notch toughness may be masked by the effects of the other elements. In any event, the notch toughness in all cases is adequate for most engineering applications.

The endurance limit and the endurance ratio of a boron steel are the same for a given hardness as values shown by other alloy steels heat treated to the same hardness.

In the amounts normally used, boron does not increase the resistance to softening on tempering, as other alloying elements do, particularly vanadium, molybdenum and

Comparison of Boron and Standard Steels

Type	Draw Temp.	Hardness Vickers 30 Kg	Yd. Pt. X1000	Ten. Str. X1000	% Elong. in 2 In.	% Red. of Area	Izod Ft-Lb
81B40	800	384	176.8	181.8	7.5	44.2	35/36
4140	900	388	168.8	180.3	12.0	49.5	28
81B40	900	340	155.1	157.9	9.5	46.0	46.5/47.5
4140	1000	340	150.8	161.7	14.0	48.6	40/47

Table 1. The notch toughness of boron steels are adequate for most engineering applications. The notch toughness of 81B40 is slightly better than that of 4140 when tempered to the same hardness, for example.

tungsten. When boron is used to replace these elements partially or completely to obtain equivalent hardenability, it is usually necessary to use a lower temperature to get a given hardness and strength. The tempering temperature for 1045-plus-boron must be lowered 100 to 150 F to match the hardness of 9440; a 150 to 200 F tempering temperature reduction is required with 1345-plus-boron to match the hardness of 4145. Although it is possible to obtain an equivalent hardness with a boron steel, it is wise to run pilot tests to determine the correct tempering temperature. The tensile strength will be the same at the same tempered hardness, even though a different tempering temperature is used.

Since boron apparently does not retard softening appreciably during the tempering, these steels will not be adequate replacements for the higher alloy steels containing molybdenum, vanadium and tungsten that are designed for high temperature service.

When the steel is annealed to a microstructure of pearlite, or of ferrite and pearlite, such as might be encountered in the center of large pieces of moderate or low hardenability grades, boron lowers the tensile strength and the notch toughness. For this reason the hardenability of a boron steel must be sufficient to obtain martensite prior to tempering, so that optimum properties can be developed at the point in the part where the highest stresses are encountered.

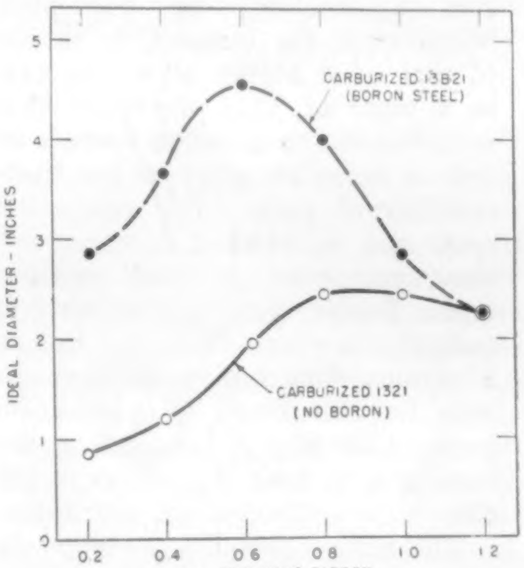
There has been very little mention of the desirable processing characteristics of the boron steels. The forging, cold heading, descaling, annealing and machining qualities of these steels are much better than those of the steels they replace. The Plumb Tool Co. increased forging die life by 25% by changing the steel used in various types of wrenches from 9445 to 1045-plus-boron. With the boron steel, 22,000 to 25,000 pieces were obtained per die sinking, where the average had been from 13,000 to 15,000 with 9445. The 1045-plus-boron steel also has a lighter and less adherent scale which was easier to remove than the scale on the 9445 and required 30% less pickling. Other shops agree that a boron steel works the same as the base composition without boron (*i.e.*, 1045-plus-boron is similar to 1045).

Boron steels are easier to anneal than the higher alloys they replace because the boron steel has about the same annealing characteristics as the base composition to which boron is added. Changing to a boron steel can cut annealing time and costs in half. Machinability can also be improved by obtaining a more desirable structure in the boron steel.

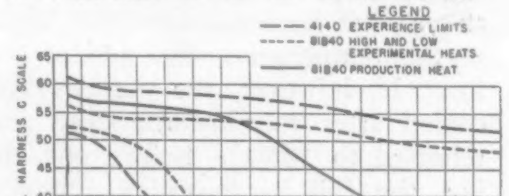
Carburizing Boron Steels

During the past few years, development work on carburizing steels containing boron has been undertaken to find a steel with hardenability comparable to 3310 and 9310 which would minimize certain undesirable characteristics of these higher alloys. The retained austenite and undissolved carbides after carburizing and hardening made expensive treatments necessary with 3310 and 9310. The United States Steel Co. developed USS SuperKore A, which is essentially 4312 with boron and 0.03 to 0.07% vanadium added. This boron alloy has been thoroughly tested by the Pratt & Whitney Div., United Aircraft Corp., for heavy duty gears, shafts and pinions and is approved for aircraft use under AMS Specification 6266. Pratt & Whitney reported improved carburizing characteristics—much less retained austenite and undissolved carbides on direct quenching.

This development has been extended by United States Steel to lower alloy contents such as SuperKore B (C4615-plus-boron) and SuperKore C (8615-plus-boron), with comparable results. Lower alloy steels containing boron have the same core properties as the higher alloy steels they match in harden-



The hardenability effect of boron decreases with increasing carbon content. When the case of this boron steel is carburized to a carbon content above 1%, the hardening properties are similar to that of the base composition.



The 81Bxx steels will match the 41xx on an equivalent hardenability basis. The hardenability of production heats seems to be exceeding the limits predicted from laboratory data.

Boron steels are easier to cold work than higher alloy steels of equivalent hardenability. These figures cover cold headed bolts.		
	8640	1035 plus Boron
Trimmer Dies—Pieces per Grind	9,000	22,100
Shear Dies—Pieces per Grind	150,000	400,000
Pointer Cutters—Hours per Grind	1	4
Rolled Thread Dies per Grind	150,000	200,000

ability. At the same time the boron steels are easier to forge, anneal, machine and heat treat after carburization because of their lower alloy content.

Two problems associated with boron in the carburizing steels deserve special attention, however. The first problem is that of the hardenability of the case. The hardenability effect of boron decreases with increasing carbon content. This means that although the core hardenability of 1321-plus-boron steel, for instance, is similar to that of a higher alloy, the case in a piece of 1321-plus-boron that is carburized to a carbon content of 1% or more has only got the hardenability of plain 1321 steel. Soft spots may be induced in heavy sections and even in small sections where fixture quenching is used to control distortion. Whether this is a serious shortcoming or not can only be determined on production parts. One way of minimizing the trouble is to limit the carbon in the case to a predetermined maximum.

The second problem presented by boron in carburizing steels is the partial or complete loss of the hardenability effect of the boron when the steel is heated to high temperatures. This apparent loss in hardenability is also found after long-time heating at carburizing temperatures followed by direct quenching. Samples of 8620 - plus - boron that are pseudo-carburized (heated in a vacuum) for 17 hrs at 1650 F or above lose hardenability—the higher the temperature, the greater the loss. If, however, the part is slow cooled after pseudo-carburizing and reheated to 1550 F before quenching, the full hardenability obtained with the normal treatment of 20 min at 1700 F is retained. The exact mechanism of this change is still a matter of conjecture.

New Boron Alloy Steels

Because of the necessity for conserving nickel, chromium and molybdenum, the American Iron & Steel Institute has announced two new series of steels designed to accomplish this purpose. These steels, 80Bxx and 81Bxx, are low nickel, chromium, molybdenum compositions in which boron has replaced about half of the critical alloy content of the 8600-8700 steels, which were the basic National Emergency steels of World War II and have since taken their place in the mass production industries.

The 80Bxx steels will match the hardenability of the 86xx-87xx types and the 81Bxx will match the 41xx types. The new alloys should be able to replace 70 to 80% of the present constructional alloy steels on an equivalent hardenability basis. The composition of these steels may have to be altered slightly, based upon production experience, since only a handful of production heats has been made. So far, the hardenability of the production heats seems to be exceeding the limits predicted from laboratory data.

In addition to the 80Bxx and 81Bxx series, three additional boron steel types show promise. These are 94B17 and 94B20 for carburized parts of heavy duty trucks and 86B45 as a replacement for 4340.

The Society of Automotive Engineers has established Division VIII of its Iron & Steel Technical Committee to collect and disseminate the experience gained in the production, fabrication, testing and use of these new steels. Represented on this committee are representatives of the steel, automotive, tractor, truck, oil well drilling, machine tool and aircraft industries, as well as the military services.

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Boron Steels in Brief

Boron steels require more care in their selection and treatment than do the conventional alloy steels, because of the following factors:

1. Hardenability must be adequate, so that a tempered martensitic structure is obtained at the location where the highest stresses are encountered. If other structures are obtained in heat treatment, mechanical properties, particularly toughness, may be impaired to an even greater extent than in conventional alloy steels.

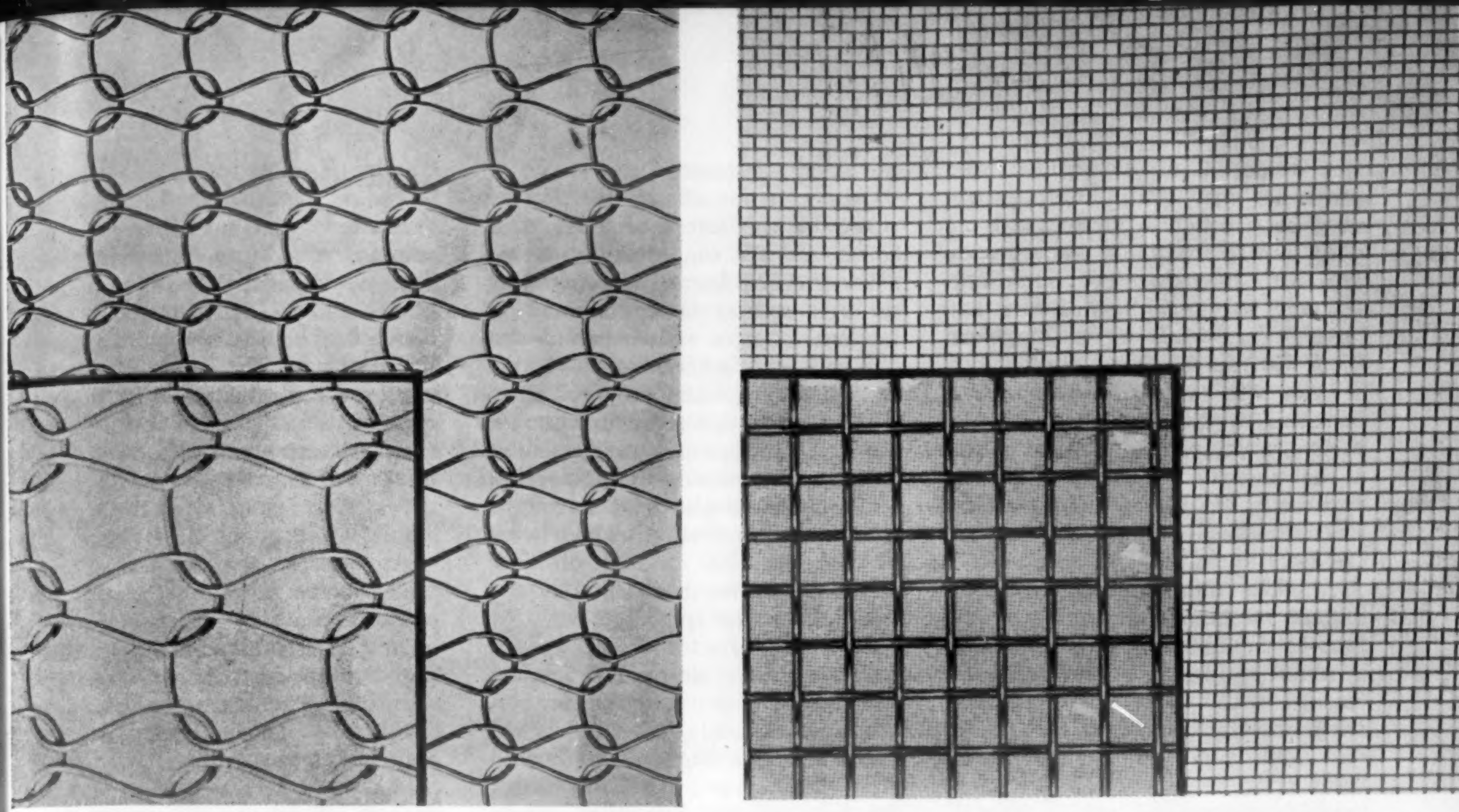
2. Boron exerts a pronounced effect on the hardening properties, but little or no effect in retarding softening at elevated temperatures. This usually necessitates a lowering of the tempering temperature to attain a desired hardness or strength.

3. Boron cannot perform the same function as molybdenum, vanadium or tungsten in contributing strength at elevated temperatures. Consequently, any attempt to replace steels high in these elements with boron steels for high temperature applications is not considered practical.

4. Because of a decreasing hardenability effect of boron with increasing carbon content, the hardenability of the case of a carburized part may be insufficient. Some improvement can be effected by limiting the maximum carbon in the case to about 0.90% carbon.

5. Carburizing, followed by direct quenching, may decrease the hardenability of the core. Either delayed quenching (*i.e.,* slow cooling to about 1550 F prior to quenching) or double treatment seems to be an effective remedy.

6. Several new series of boron alloy steels have been developed to conserve our critically short alloys. By concentrated attention to details, it is felt that these steels will have fairly wide application.



Details showing the differences between knitted (left) and woven mesh structures. (All illustrations courtesy of Metal Textile Corp.)

Knitted Metal Parts Have Unique Industrial Applications

by S. G. KELLEY, JR., Assistant Editor, Materials & Methods

Metals knitted into a mesh structure have characteristics that suit them for such diverse uses as filtering, vibration control, removal of entrained gases, and electronic shielding.

• THE NEEDS OF INDUSTRIES confronted by such problems as filtering or straining of fluids and gases, cushioning or vibration control, electronic shielding, the removal of liquids entrained in gases, and the separation of immiscible liquids are being met with high efficiencies by elements made from knitted wire mesh. Because of the wide range and unusual combinations of physical, chemical and electrical properties in which these elements can be produced, their use is becoming increasingly widespread in a variety of industries. From a start in the automotive industry as air filters for tractors and trucks, they have found their way into such items as mist eliminators, shock absorbers, resilient gaskets for high and low temperature use, and a host of other equipment.

Knitted wire meshes are just what their name implies—metals knitted into a mesh structure in very much the same way as stockings or sweaters. They are in no way related to the woven metal materials familiar to most as fly screens. A comparison of the basic structures of the two materials in the accompanying photographs shows that whereas weaving produces a symmetrical mesh, usually with square openings and parallel wires, knitting results in an asymmetrical mesh of interlocking loops. This gives knitted materials a stability and, at the same time, a flexibility unattainable with woven meshes.

Woven materials depend upon the size and shape of the wire used to determine the size of the holes while the interlocking loop structure resulting from knitting makes this factor relatively inconsequential. Furthermore, knitted materials are far more resilient than woven ones and, unlike woven meshes, are not readily distorted permanently from their original planes by temperature variations.

Properties of Knitted Mesh

The properties of knitted wire materials are largely attributable to two factors. One is linked-loop structure and the other is the large assortment of materials from which the mesh can be made.

Knitted wire has both a large surface area and a high percentage of

free space. Contradictory as these properties may seem, knitting permits construction of a mesh using wire with a maximum surface area and with interstices of almost any desirable size, regardless of wire diameter. Fine wire, for example, of 0.0005-in. dia has been knitted into a mesh with as few as three to five openings to the lineal inch. Such parts as a compressed mesh filter for a fuel injector in a diesel engine, apparently too firm to be deformed when squeezed between the fingers, can have up to 85% free volume.

Another important property of knitted meshes is resiliency. Every loop of the knitted structure becomes a small spring when subjected to tensile or compressive stresses and, when not distorted too drastically, will immediately resume its original form upon relief. Even when the mesh is compressed into a special shape, a high degree of resiliency is retained. This can be controlled, within certain limits, by varying the size of the knitted loops, the type and size of the wire used, and the pressure used in producing the forms.

Knitted wire construction also offers a number of desirable electrical characteristics. It is said to be ideal for electronic shielding. Inductances at radio frequencies are high and the continuous-loop structure apparently causes induced currents to cancel themselves. The electrical conductivity of the material, however, is not the prime basis for selecting shielding materials. Gaskets of monel, for instance, have been found to shield as effectively as silver-plated copper ones and give better corrosion and salt spray resistance.

Also electronically valuable is the shape of the interstices. As their forms are not simple ones such as squares or circles, light penetrating through several layers oriented at random emerges rather evenly distributed and without any definite zoning pattern when projected upon a screen. This is important in certain electronic applications as it indicates that electrons passing through such a structure would also tend to emerge in an even distribution without areas of concentration and rarefaction, which would be detrimental to the operation of the apparatus.

Another characteristic of knitted metals is their ability to maintain their overall dimensions despite thermal expansion and contraction. When the meshes are slightly stretched in every direction and expansion occurs, the sides of the loops are merely forced closer together without change in overall dimensions or plane.

Coupled with the attributes of the knitted structure are those of the wire material itself. Knitted meshes can be made of steel, copper, brass, monel or any other metal or alloy (and a couple of plastics, for that matter) that can be drawn into wire. Such a variety of materials, of course, provide a wide range of such properties as strength, corrosion resistance, wear resistance, electrical and thermal conductivity and heat resistance with those already mentioned.

Further variations dependent upon the uses of the final products are obtained by utilizing various devices to gain additional strength and weight in the meshes.

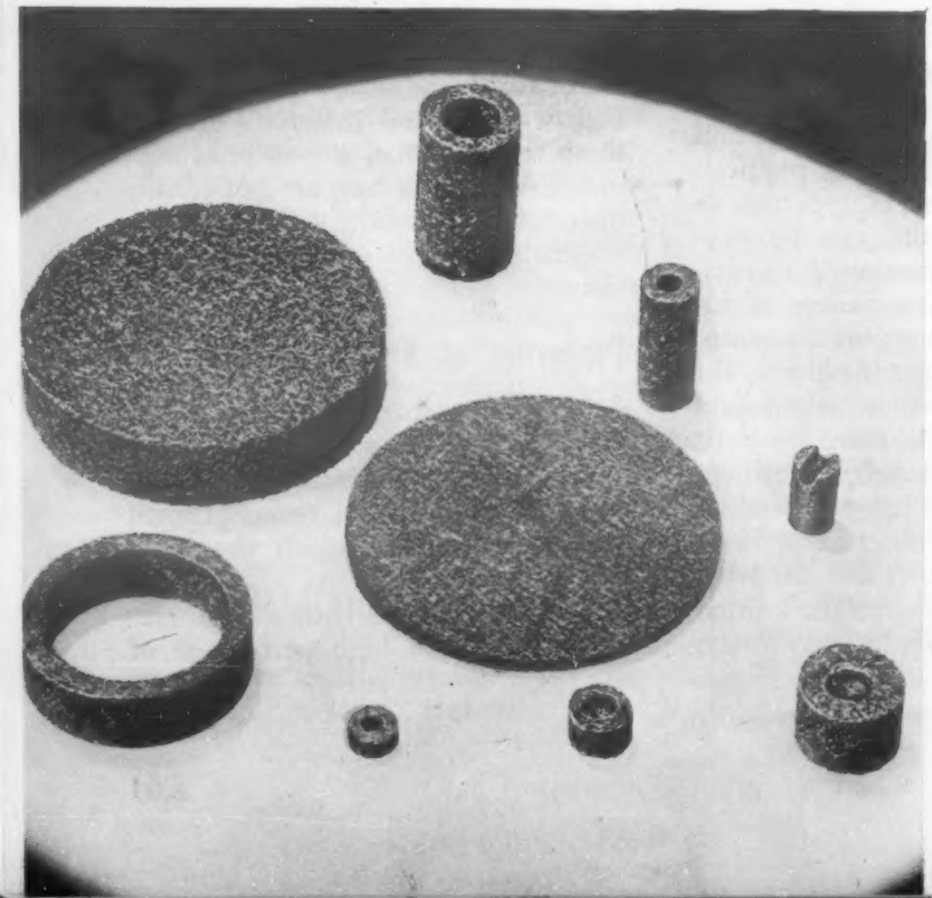
Applications

Knitted metal units give good results in removing one material from another, whether a separation of two phases of the same material, two immiscible liquids or a solid from a liquid or gas. The densities of these units are controlled to meet the requirements of specific problems by varying the compression used to form or shape them, the size and shape of the wire and the size of the knitted loops.

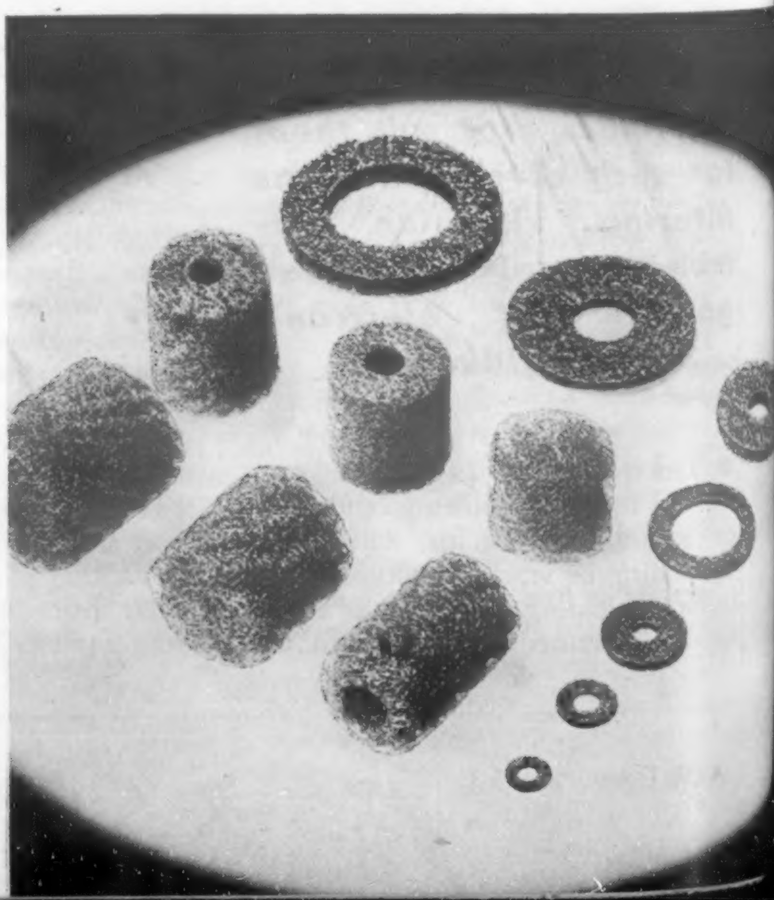
An example of this type of application is the separation of a liquid phase from a gas phase as performed by mist eliminators. Here gases bearing droplets from such processes as distillation, evaporation, scrubbing, cleaning or absorption are put through built up layers of knitted fabrics from $2\frac{1}{2}$ to 6 in. thick. As they go through, the droplets impinge upon the wire loops, where they accumulate and slowly run through to the bottom surface. There they continue to pick up other droplets and increase their size until they have gained enough weight to drop off and fall against the rising flow of gas. The gases, on the other hand, have little difficulty in flowing through the eliminator due to the large volume of free space available, and velocities of 2 to 10 ft per sec are easily handled at pressure drops as low as $\frac{1}{2}$ in. of water.

Mist eliminators can be made to fit apparatus of any size, the largest to date being 28 ft in dia. At such dimensions, they are cut into sections that will make installation through a manhole possible. They

Examples of small filters of compressed mesh.



Compressed knitted mesh washers and forms for cushioning and vibration control.



generally consist of layers of crimped mesh, each layer with its crimps at an angle to those of the layer below so that a maximum of free structural rigidity will result. Small eliminators, however, are usually one piece, wound units of much simpler construction.

The efficiency of knitted metal fabrics for mist eliminating purposes has apparently proved excellent, and liquid droplets the size of paint spray particles — five to 20 microns — or bigger are separated with efficiencies claimed as high as 98 to 100%.

Closely allied is the selective separation of two immiscible liquids, such as oil in boiler feed water. Acting on approximately the same principle as above, knitted wire treated to have a greater affinity for oil than water, is used. As the oil collects on the wire, it rises through the mesh to collect at the upper surface of the de-oiler whence it can be drained from the apparatus. Again, separation is said to be highly efficient with little coincident loss in the pressure of the cleaned fluid. Filters for various automotive uses illustrate further applications of the same nature dependent upon similar qualities of the knitted wire.

Still other properties have made knitted meshes applicable to electtronic instruments. Their ability to pass electrons without forming zoning patterns and their large free space permitting almost unrestricted particle transmission, together with their ability to compensate for thermal expansion variations, are said to make them excellent materials for tube elements.

When tightly compressed, knitted metals manifest themselves in electrical applications such as electronic "weather stripping." The meshes are pressed into gasket shapes which can be used in high frequency electronic assemblies in such a way as to prevent radiation of undesirable frequencies (radio noise). Their high inductance at elevated frequencies is probably one of the reasons for their wide use as electronic shielding in high frequency apparatus. Still others are formed of compressed knitted mesh bonded to a sealing medium of neoprene or other rubber compounds for sealing in conjunction with shielding.

For vibration control and cushioning purposes, knitted mesh parts and forms are gaining increasing importance in meeting situations in which organic materials, commonly used under normal circumstances, break down. The knitted wire elements maintain their desired cushioning properties over a temperature range from –75 to 200 F, one far greater than that in which organic materials are effective. Furthermore, resiliency can be controlled to give optimum cushioning for loads up to 5300 to 5400 lb.

The corrosion resistance of various metals also makes them useful for cushioning where the presence of corrosive agents may make the use of other materials prohibitive.

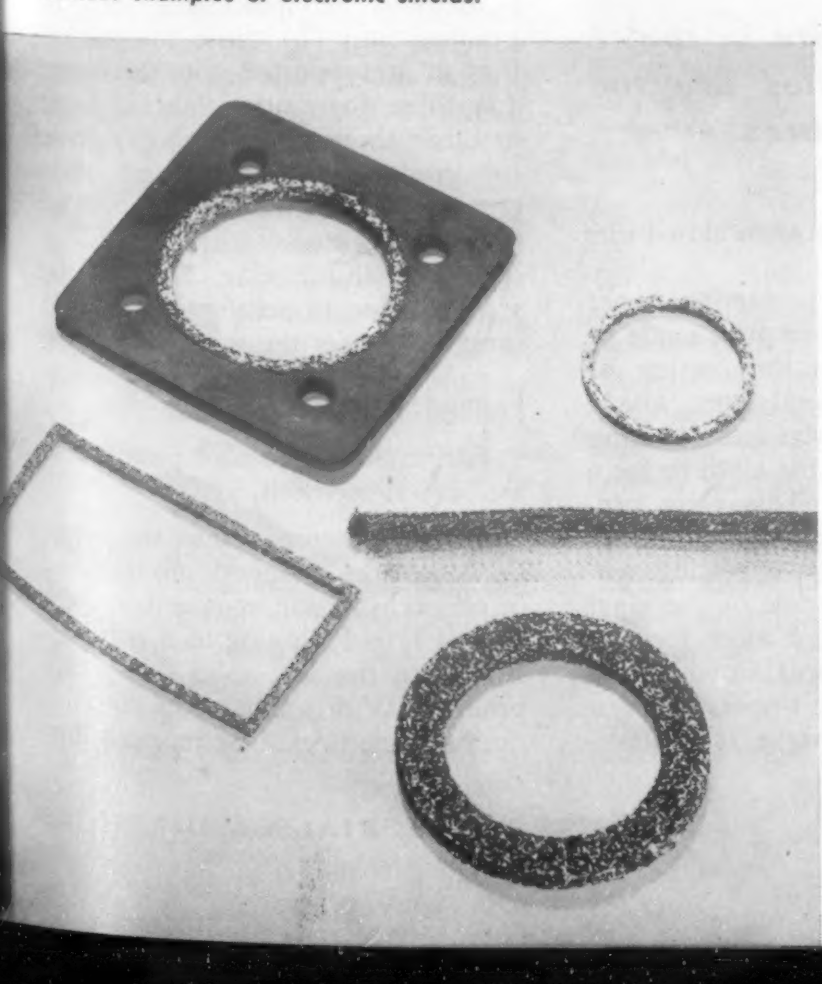
Washers for cushioning porcelain insulators in electrical systems utilize the resilience of compressed knitted meshes as substitutes for the more widely used organic materials wherever wide temperature variations or danger of atmospheric, fungicidal or bacterial attack are prevalent.

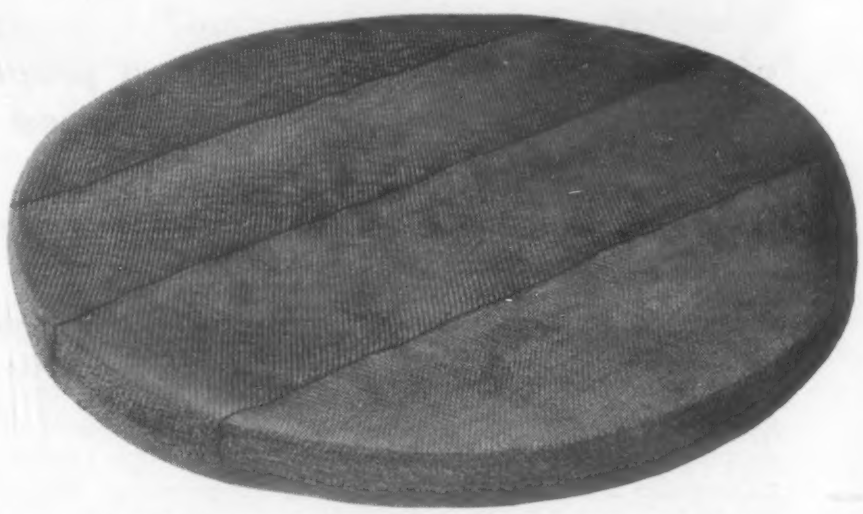
Shock mounts for aircraft instruments employ knitted metal shock absorbers for other reasons. These are formed to function with the desired resiliency and meet the requirements for effective cushioning at the very low temperatures encountered in flight. At such temperatures organic compounds are generally hard, brittle and useless.

Temperatures of 1500 to 1800 F are met equally well by the versatile materials, as illustrated by their use for expansion joints in aircraft exhaust systems. The various uses can be drawn into a lengthy list to include such items as: radar reflectors to aid in the location of life rafts in which the knitted reflector is rather loosely knitted with large interstices and gives a high reflectivity to radar signals equal to that of a material 85% solid but without wind resistance; contact electrodes for use in shock therapy; a sweater (yes, metal) for a radio commentator who jokingly spoke of the possibility; and a metal tennis ball which would not wear out and, though it did bounce, was somewhat unsatisfactory as a substitute for the real thing.

There are, of course, certain types of equipment requiring wire mesh components which are out-of-bounds to knitted meshes. Such applications as insect screens and sieves for grading particles according to size are typical examples. As a general rule, anything requiring a mesh with a rigid structure and openings of exact size has no place in it for the flexibility of knitted wire meshes.

Various examples of electronic shields.





Four-ft dia mist eliminator showing sectional construction.

Direct Forming of Rubber and Plastic Products from Dispersions

by KENNETH ROSE, Western Editor, Materials & Methods

This car trim assembly leather is a vinyl plastisol coated fabric manufactured by L. E. Carpenter and Co. (B. F. Goodrich Chemical Co.)

Simplicity, low cost of equipment, flexibility in choice of materials, and good physical properties are the main advantages of dip-formed pieces.

● SEVERAL IMPORTANT NEW applications have caused increased interest in direct forming of synthetic rubber and plastics from a dispersion of the material in water or other dispersing agent. Electrical units have been given an insulating coating by simple dipping instead of by molding a soft rubber cap and stripping it over the assembly; artificial plants have been made by knife spreading of the material into an open mold; flameproof clothing has been made by a simple coating operation; aviators' masks have been made by spreading of a pasty resin into an open mold, instead of molding between closed dies under pressure.

This method of processing is not new. One of the first uses made of natural rubber was the coating of cloth with the natural latex which, after removal of water left a coating of crude rubber on the cloth to form rainwear material. This early process has been extended to use artificial latices, made by dispersing synthetic rubbers and some of the vinyl plastics in water, and more recently by the use of plastisols, in which the vinyl elastomer is dispersed in a chemical that will serve as a plasticizer for the resin itself. The basis for the process is in all cases the same, and consists of coagulating the microscopic particles of the dispersed suspended solid material into a continuous solid, in a mold or over a form. While no actual change takes place in the composition of the particles of solid, the physical change produces a film or formed piece of the elastomer from a syrupy liquid.

Forming from dispersions has been used as a processing method for natural rubber; synthetic rubbers, and especially the styrene rubbers; vinyl plastics, and especially polyvinyl chloride. The synthetic rubbers and natural rubber are used as latices, while the vinyl polymers can be worked from water dispersions or latices, and are being used most successfully as dispersions in a plasticizing material. In the plasticizer dispersions the composition is so balanced that the amount of plasticizer serving as the dispersing medium is just sufficient to be taken up by the resin to form a soft elastomer, so that there is no necessity for evaporation, and no shrinkage.

Methods of processing can be grouped into (1) those for producing an unsupported film or sheet; (2) those for coating fabrics, paper or other sheet stock; and (3) those for producing formed pieces. Processes for producing the unsupported film or sheet stock include extruding, spreading and casting, followed by a coagulation or setting. Coating of sheet stock uses the same operations.

Formed Pieces

For producing formed pieces there are several methods, as follows:

Simple dipping—Here the form, or workpiece, is dipped into the latex or other dispersion, removed, and the film of liquid clinging to it is coagulated into the soft solid that is the product. With small pieces, the film can be made thicker by repeated dip-

ping. When used with the synthetic rubber latices, this process is especially suitable for making small pieces with thin walls, such as thin rubber gloves. With the more viscous plastisols, simple dipping is one of the most useful forming methods, and relatively thick objects can be produced by a single dip.

Coagulant dipping—The form is first treated with a chemical coagulant, then dipped in the latex. This method is used with the natural and synthetic rubber latices only. The coagulant increases the amount of ubber taken from the latex.

Electrodeposition—The particles of ubber are capable of taking an electrical charge, and can be deposited on the workpiece by the action of an electric current similarly to the deposition of metals in plating. This method is not as widely used today as in the past, but it is still advantageous for certain applications, such as the rubber coating of large tanks of irregular shape.

Slush molding—The liquid or paste can be poured into an open mold, poured out again, and the adhering film heat treated. This method has been especially successful with the plastisols, which are viscous liquids, for production of hollow pieces.

Casting—The liquid or paste can be poured or knifed into an open mold, heated to fusion temperature, and the piece withdrawn. This method is much used with the plastisols for production of solid pieces. A calking gun has been used to fill molds where high production is desired.

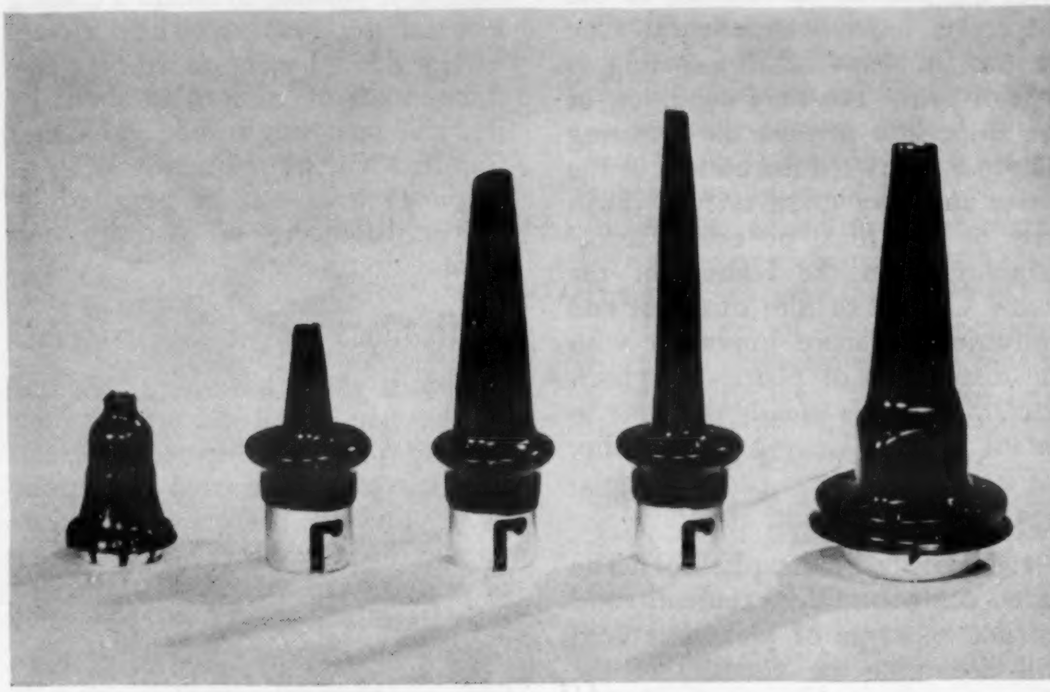
Outstanding advantages of these methods for using dispersions are their simplicity, and the low cost of the equipment necessary. They also make possible the production of some forms, especially those consisting of thin films, that would be difficult or impossible to produce otherwise.

Molds can be made very simply, and of lightweight materials, as no pressure is used in the molding process. Female molds for slush molding or casting are usually made of light aluminum sheet, steel sheet, or of plaster of Paris. However, for use with the plastisols, molds must be capable of withstanding temperatures of 300 to 350 F, as the work is fused as such temperatures. This requires a special plaster.

Another advantage is that a certain flexibility is gained in the use of materials, especially in the dip process. Codipping can be accomplished by mixing latices of several types of synthetic rubbers and dipping the form in the mixture. It is necessary that the materials be compatible. Styrene synthetics are highly compatible with natural rubber, and chloroprene and acrylonitrile types are compatible to a lesser degree. This permits compounding with chloroprene-acrylonitrile mixture to give oil resisting properties to the film, or formulating to give improved resistance to normal oxidation, sunlight and heat, which mean better resistance to aging.

Physical properties of dip-formed materials are higher than in molded goods because the original properties of the material in the latex are better maintained by the dipping process. Tensile strength and elongation can be of the order of 6000 psi and 1000%, respectively, though they can be compounded to much lower values.

Although the equipment required for using the dispersed rubbers or the plastisols is simple and inexpen-



These vinyl dipped parts include an instrument panel socket (left) and varied license lamp and parking lamp sockets. (B. F. Goodrich Chemical Co.)

A cardboard oil container used in France in place of scarce tin cans. Greaseproof qualities are obtained by coating inside of container with Geon polyblend latex. (B. F. Goodrich Chemical Co.)

sive, the making up and use of the dispersion requires experience. One of the problems of dip coating is that of drip. The fluid condition of the dispersion permits the adhering film to flow toward the bottom of the piece, and may cause uneven thickness of the film, or even "tears" dripping from the bottom of the form. Control of film thickness and uniformity is more important with the dispersions of plastics in plasticizer, where it is usually desirable to obtain a thick coating in one dip. Here results are obtained by regulation of the following factors:

1. Viscosity of the plastisol. The resin content, filler content, and amount and type of plasticizer used will determine the viscosity of the dispersion. Use of a mixture of plasticizers is the rule, and some one of them is used especially to control viscosity. Dioctyl is a typical low-viscosity plasticizer.
2. Preheating of the workpiece or form to be dipped. A thicker build-up of resin is obtained by warming the work before dipping.
3. Time in the dispersion. This may vary from a few seconds to a few minutes, with longer time for the thicker film. The speed of immersion and withdrawal is a part of this factor.

By careful control of these conditions it is possible to obtain a coating in which thickness can be held closely to any desired value of from a few thousandths of an inch to about 1/4 in., and in a single dip. A viscous film that will set sufficiently in air to eliminate tears can be prepared by proper balancing of viscosity and formulation.

Applications

Rubber gloves have long been one of the standard items produced by dipping forms into dispersed rubbers. They are also made from dispersions of vinyl resins. Dispersions of chloroprene or acrylonitrile rubbers, or of vinyls, can be used where oil resistance is needed. Pickling and plating operations, battery manufacture, food manufacture, chemical plants and photographic equipment manufacture are some of the industrial operations that make use of rubber gloves for worker protection; and surgeons, housewives, and food handlers are typical of other users. Thicknesses range from very thin gloves for surgeons to extra-heavy duty gloves for industrial use. Palms and fingers of industrial gloves can be roughened to provide a better grip with wet objects.

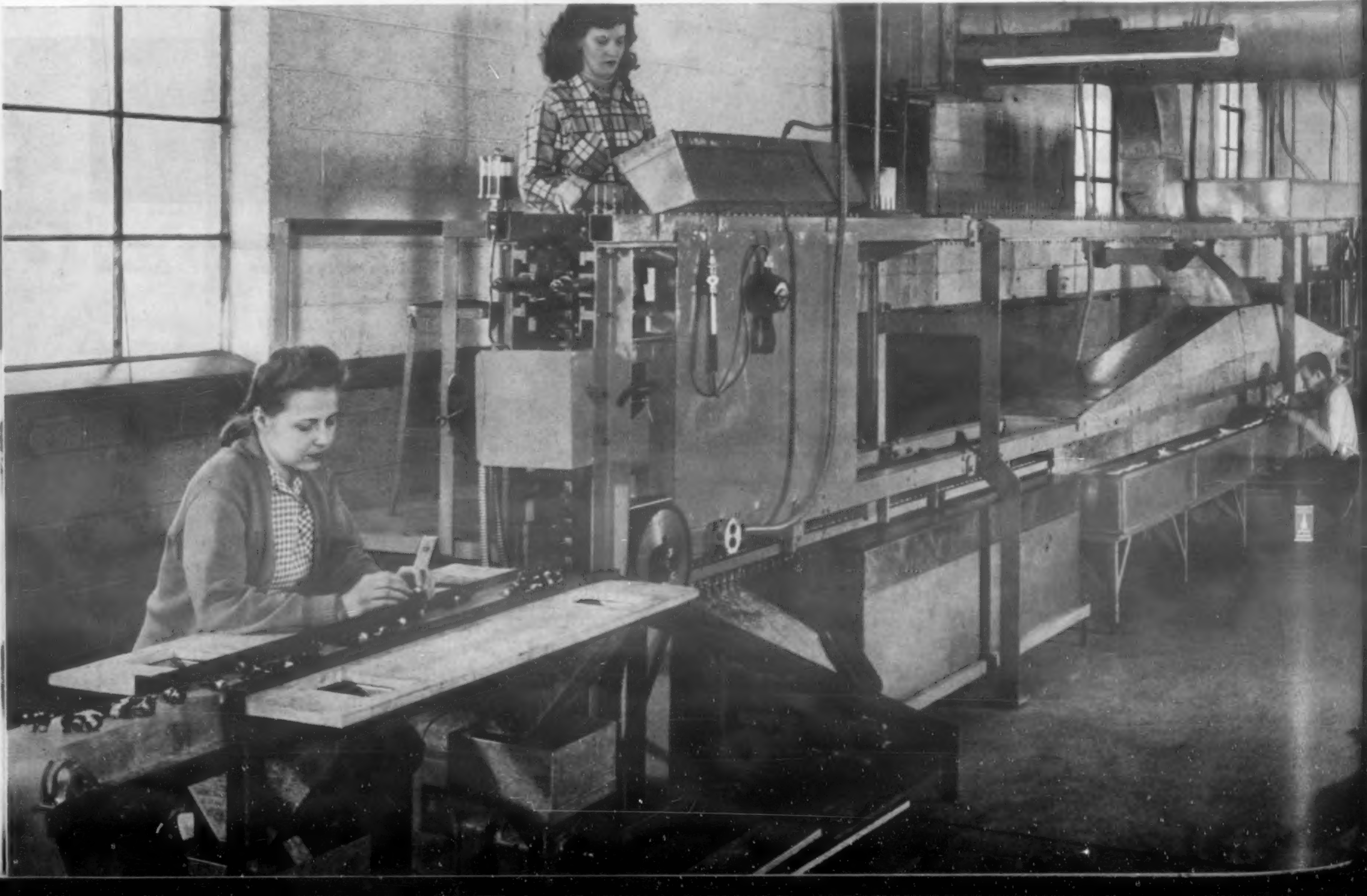
Special clothing for chemical workers is made by coating fabrics with a vinyl resin to provide acid and alkali resistance. The coated fabrics are resistant to mineral and organic acids, alkalies, hydrocarbon chemicals, corrosive salts, and oxidizing agents. In addition to chemical resistance, the treated cloth remains flexible at low temperatures, is light in weight, will not support combustion, and can be fused at the seams to provide a continuous surface.

A fiber drum intended for shipping lubricating grease, textile sizing, and similar materials has been grease-proofed with a coating of polyvinyl chloride latex. The coating can be applied to the exterior of the drum to provide water resistance, washability and abrasion resistance. The coating does not tend to chip or flake off.

Fiberboard containers treated with a vinyl resin blended with an acrylonitrile synthetic rubber are in use in France for packaging motor oil and other petroleum products. The package has a heat-sealed pouring spout, with a metal clip crimped over it to insure against leakage. The blend is applied as a water dispersion, thus avoiding the cost and fire hazard in the use of organic solvents.

An artificial chamois skin, made by impregnating a felted fabric with an acrylonitrile synthetic rubber latex, has recently been announced. It is intended to duplicate the uses of chamois leather in polishing and cleaning, with both domestic and industrial applications. For car wash-

Continuous dipping operation in a production line, as shown here, reduces costs. (Watts Electric and Manufacturing Co.)



Rear of an automobile speedometer showing instrument panel socket assembled. In foreground, dipped and undipped socket. (B. F. Goodrich Chemical Co.)

ing and other industrial purposes, it has the advantage of costing about one-third as much as chamois leather, and of being unaffected by gasoline, grease, chemical detergents, and salt water, while absorbing water readily. Tests seem to indicate that it may outlast chamois leather about three to one.

Aviators' goggles and masks were made of molded rubber during the wartime demand for these items, but it was found that a dipping process would produce a more flexible, more satisfactory piece of equipment, and a change in methods was made. The dipped masks, made over a form immersed in rubber latex, were thinner than the molded pieces, stronger, and more comfortable to wear.

A coated fabric with deep-embossed surface pattern is being used for automobile interior trim in a wide variety of colors. The coating is a vinyl resin, laid down from a plastisol dispersion. Film thicknesses up to 0.025 in. are produced in one or two passes on a coating machine. The coated material is waterproof, resistant to scuffing and staining, and does not chip or crack. Similar material is being used for upholstery, awnings, window shade cloth, and other like purposes.

An important change-over in the method of covering automotive light sockets and plugs is reducing costs and bringing improved performance, while saving rubber. Parking lights, tail lights, and head lights are subject to corrosion and poor contact due to moisture and dust entering the socket assembly. Protective rubber boots, sealing gaskets, and grommets have been used to exclude moisture, but with only partial success. All of these protective devices were costly to produce and install. The present protection is a single-dipped coating of a vinyl chloride resin from a plasticizer dispersion. By closely controlling the compounding of the plastisol, the prewarming temperature of the metal sockets, and the speed of dipping and withdrawal, the coaitng is held to 0.040-in. thickness within close limits. As the coating is formed directly onto the metal socket as a tightly adhering film, there is no danger of moisture seeping into the assembly.

The high production required has made necessary the development of continuous dipping units for these sockets. A 70-ft machine begins with a prewarming oven, into which the sockets are carried on arbors attached to a roller-type chain. From the oven chain moves into the dipping bath, where a gel of resin-and-plasticizer forms on the warmed surface of the socket. The layer builds up during the time of immersion, and the conveyor chain moves the pieces out of the bath after a predetermined time sufficient to give the layer thickness desired. The conveyor chain then carries the coated sockets into another oven where, at a temperature of about 350 F, the gel is fused. Infra-red lamps are used for the heating. During this heating the gelled dispersion of vinyl resin in plasticizer undergoes a change, the resin taking up the plasticizer and becoming a continuous soft solid of plasticized vinyl polymer. A dip into a refrigerated bath for cooling completes the coating operation.

Three of these machines now in operation at Watts Electric and Manufacturing Co., Birmingham, Mich., can produce a total of 280,000 coated sockets per 24-hr day. In addition to the sockets, ignition coils, body harness clips, ordnance and aircraft connectors, ignition equipment, etc., can be dipped by changing arbors on the machine.

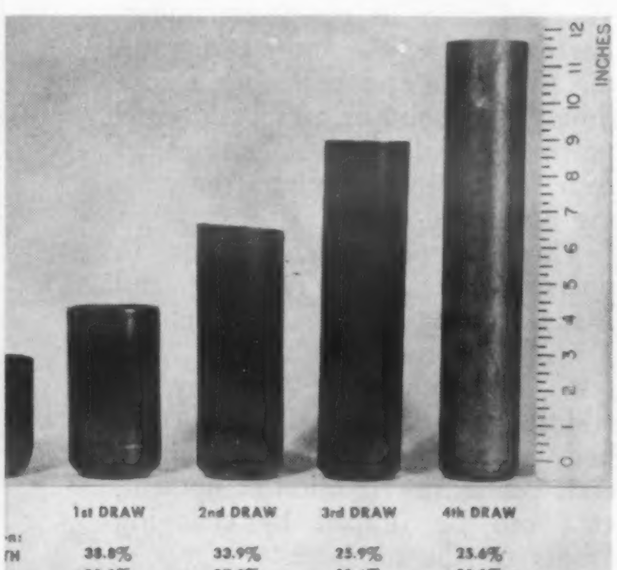
Plastisols find another outlet in the production of simulated plants. These plastics plants are artistically molded in open aluminum molds to match the structure and color of natural vegetation. The plastisol is knifed or fed from calking guns into the molds, then heated at about 300 to 350 F to fuse the resin. The resulting artificial foliage is popular for decorating hotels, night clubs, motion picture sets, etc., because it does not require attention, is flameproof and washable.

A floor covering consisting of a photoengraved cellulose sheet coated with a 0.005-in. vinyl protective surface, and laminated to a backing of asphalt-saturated fiber, is finding favor. It is lower in cost than linoleum or rubber tile, resists scuffing, and is unaffected by any of the common household detergents. The range of colors and designs is almost limitless, as they are printed onto the cellulose sheet before coating. The coating is laid down from a vinyl-plastisol, which is fused to complete the process.

New Metal Treating Process Speeds Cold Working, Cold Extrusion of Steel

—NEW PROCESS PREVIEW

A special phosphate coating and organic lubricant combine to give a heat resistant lubricating surface that has exceptional adherence under severe working conditions.



Deep drawing of a hollow cylindrical component using a single application of Foscoat lubrication. The four draws were accomplished with no intermediate annealing.

● A NEW METAL TREATING chemical process which extends lubrication limits in the cold working of steel was recently announced by the Pennsylvania Salt Manufacturing Co.

Designated as the Foscoat Process, it consists of compatible cleaning, pickling and application of a new phosphate coating and specially developed lubricants to steel. The process has been successfully employed in conjunction with all grades of plain carbon and SAE alloy steels as well as some medium alloy grades. It is not intended, in its present state of development, for use with stainless and other high alloy steels.

Foscoat itself is a specially formulated phosphate coating which can be applied by immersion, flooding or spraying, and forms a strong, adherent coating chemically bonded to the steel. This highly absorbent coating functions as a host for Foslube, an organic lubricant which is designed to react chemically with the phosphate coating, in addition to being physically adsorbed and absorbed. The combined action gives a heat resistant lubricating surface interlocked with the metal, and provides exceptional adherence even under the most severe working conditions.

In view of the importance of proper pre-cleaning and preparation for cold working, the complete process was worked out to include pickling and special alkaline cleaners. This is an advantage to many users in that one source is able to supply a complete, integrated process, with all necessary chemical ingredients as well as technical service for the entire cold working operation. The technical service phase includes layout and equipment design as well as mechanical engineering service on tool and die design.

It was to improve earlier German work in cold extrusion that the new phosphate coating chemical bath was developed by the Heintz Manufacturing Co. of Philadelphia. A joint research by Pennsalt and Heintz followed and resulted in the evolution of the integrated Foscoat metal preparation process.

The efficiency of the Foscoat Process has been successfully demonstrated in cold extrusion and, therefore, brings this fabricating technique one step nearer to general commercial use. The next step awaits the general availability of press equipment of sufficient size and design to take advantage of the raised lubrication limits.

But of more immediate importance to industry are the remarkable results which have been attained in such applications as tube drawing, wire drawing, deep drawing (ironing), deep stamping, cold heading and similar cold working operations. In these operations there generally exist two limitations—lubrication and the ductility of the metal. The former limitation is virtually eliminated by the chemically bonded lubrication film imparted to steel surfaces by the Foscoat Process.

Significant economies resulting from this improvement in lubrication include elimination of intermediate press operations, as well as annealing and chemical treating operations, additional reduced consumption of chemicals because of compatibility, increased production with existing equipment, savings in metal or reduction in scrap losses, and considerable extension in the life of costly dies.

Typical Applications

In wet drawing of fine steel wire, for example, commercial application of the Foscoat process resulted in a 40% increase in the rate of production—actually to the highest rate of capacity of the drawing equipment. Despite this speed-up, die life was increased 2½ times. In dry drawing of steel wire shapes, such as triangle and square wire, from round stock, one application of the process permitted drawing to finished shape without the intermediate anneals and recoating required in previous processes.

Production use of the process at

Heintz Manufacturing Co. has made possible substantial economies in the fabrication of automatic washing machine tubs. Reductions in scrap losses due to rejects and in downtime for stoning of dies have resulted in an increase of 140% in output.

In deep drawing (ironing) of steel cartridge cases, 80% reductions in wall thickness in the metal were possible with a single application of the Foscoat process without intermediate annealing. This represents a 100% improvement over conventional practice.

In actual production in rod-pulled tube drawing, over-all reductions of 80% were achieved with a single application of the process, or about 60% improvement over that previously obtained. In another tube mill, using plug drawing, over-all reductions of 60% were obtained with one application of Foscoat, which is also a 60% increase over existing practice.

Considerable savings are also in prospect in commercial cold extrusion, for it can often eliminate the necessity for forging or upsetting of heated billets. These operations generally require a starting billet twice the size of that necessary for cold extrusion. The forged shape usually required extensive scrap-generating machining.

Also, savings are possible by adapting plain carbon steel for applications ordinarily requiring steels containing critical and expensive alloying material. Cold extrusion involves the concept of steel as a plastic material which, when the barriers of friction are sufficiently extended, will flow under pressure. Stressing the steel in compression in contrast to cold drawing where forming is performed by stressing the metal in tension, permits a drastic kneading action that increases strength characteristics considerably, with but slight effect on ductility.

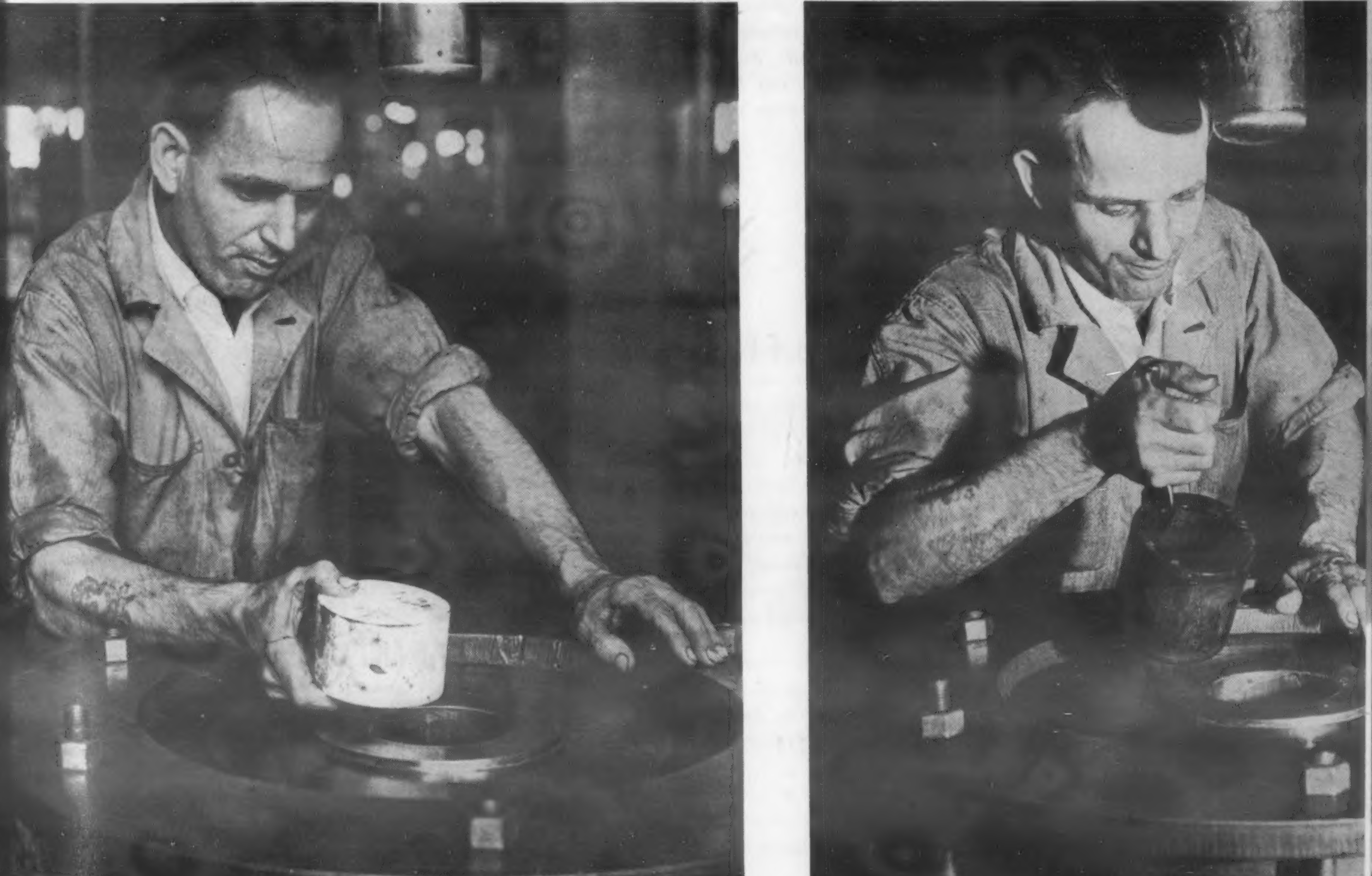
Cold extrusion, made possible by improvements and modifications to phosphate coating techniques, was developed and used in Germany during World War II, principally as a steel-saving device, to produce cartridge cases, other ammunition components, gun barrels, airplane parts and other tubular or cylindrical bodies.

While the process already is being used in regular operation in various cold working plants, Pennsalt's immediate objective is to extend it to other cold working operations where it may be applicable.

Meanwhile, both in cooperation with the government and in private industry, large scale production experiments and actual production in the field of cold extrusion are being carried forward. In this connection technical data are being supplied to machinery manufacturers and die designers.

Simultaneously, both Pennsalt and Heintz researchers and those of other cooperating companies are participating in research and development of further applications, which include the use of this coating as a paint bond, and in rust-proofing and other types of metal coating.

Backward cold extrusion employed as first step in forming a hollow cylindrical body. Left shows steel billet treated with Foscoat; right shows cup formed in a single press operation.

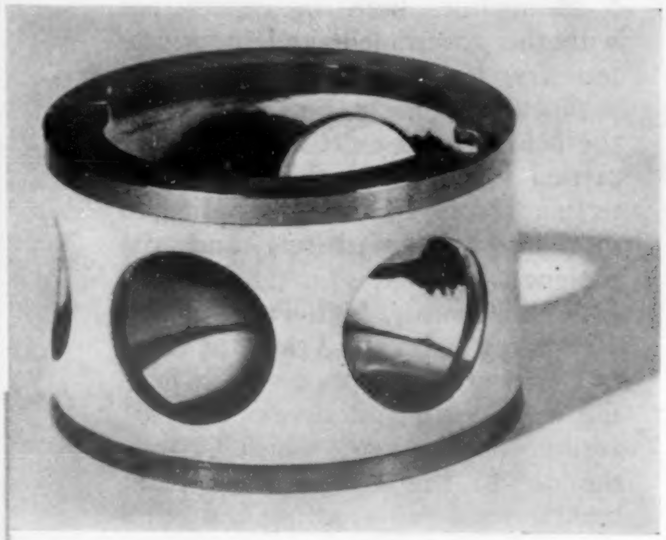


Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

Older, basic materials in new applications . . .



PORCELAIN ENAMEL FUEL VALVE

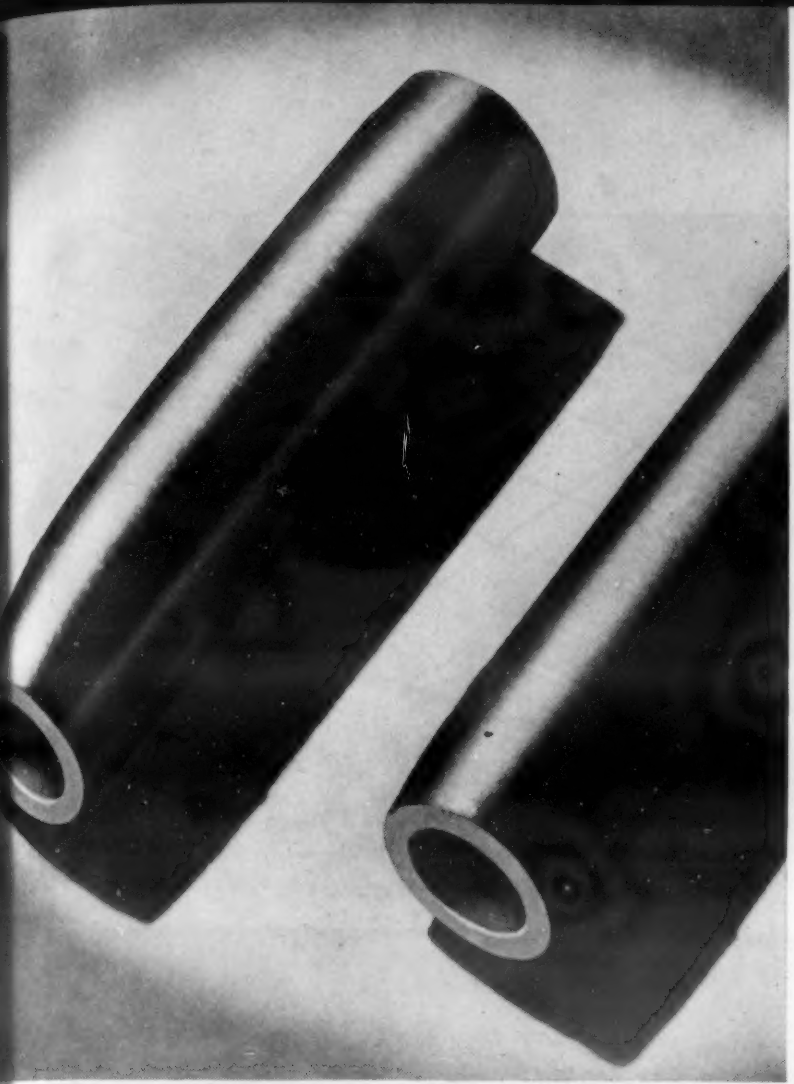
The Aero Supply Manufacturing Co., Inc. combines a corrosion resistant metal body and a special acid resistant porcelain enamel finish to give an aircraft fuel valve which outperforms previous all-metal designs. These valves must operate at extreme temperatures, under corrosive conditions such as the presence of salt water spray and chemical fuel additives, and must resist abrasion from dust and sand contamination. One test for these valves requires them to operate for several thousand cycles, perfectly dry. The valve is made by casting the body in stainless steel and machining it to precise dimensions, recessing the exterior diameter to receive 0.015 to 0.020 in. of porcelain enamel. An unusual operation, not usually considered with porcelain enamel, is the final grinding and lapping operation which brings the diameter tolerance of the plug to within plus 0.001 in. and minus 0.000 in.

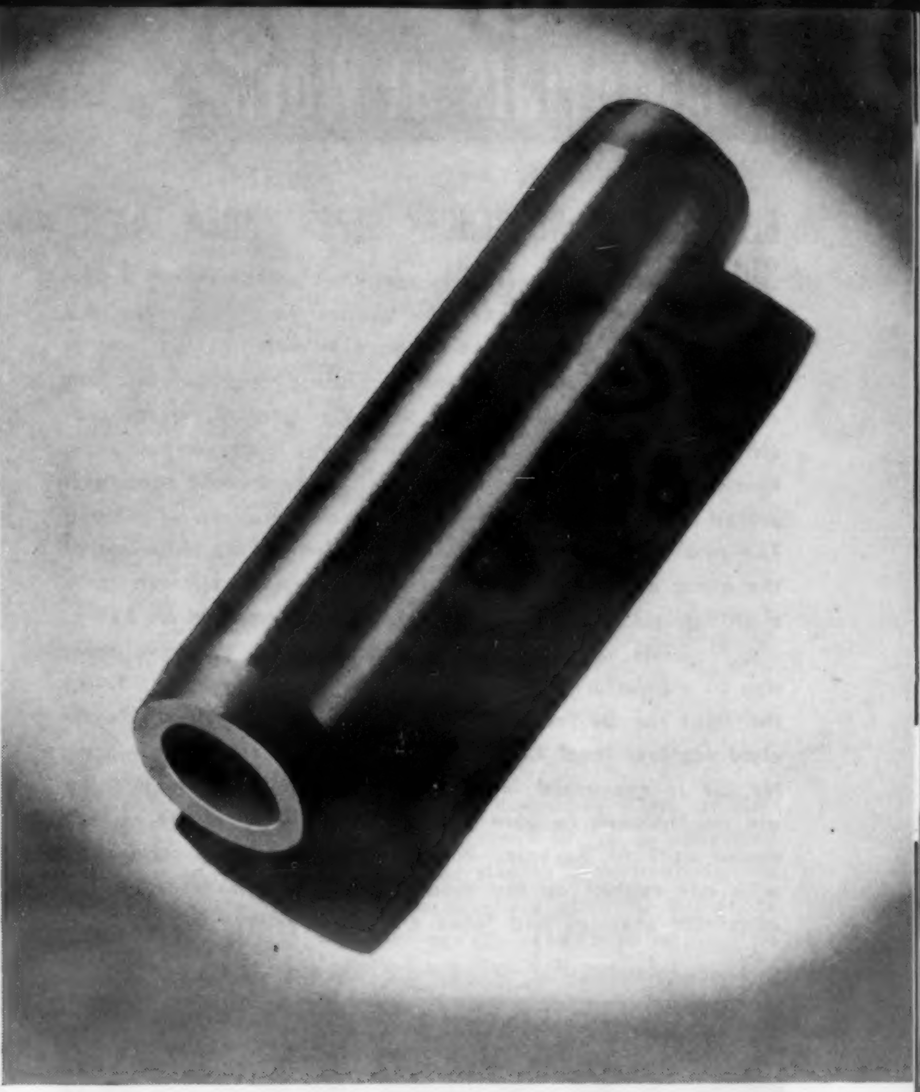
EXTRUDED FLARE PART

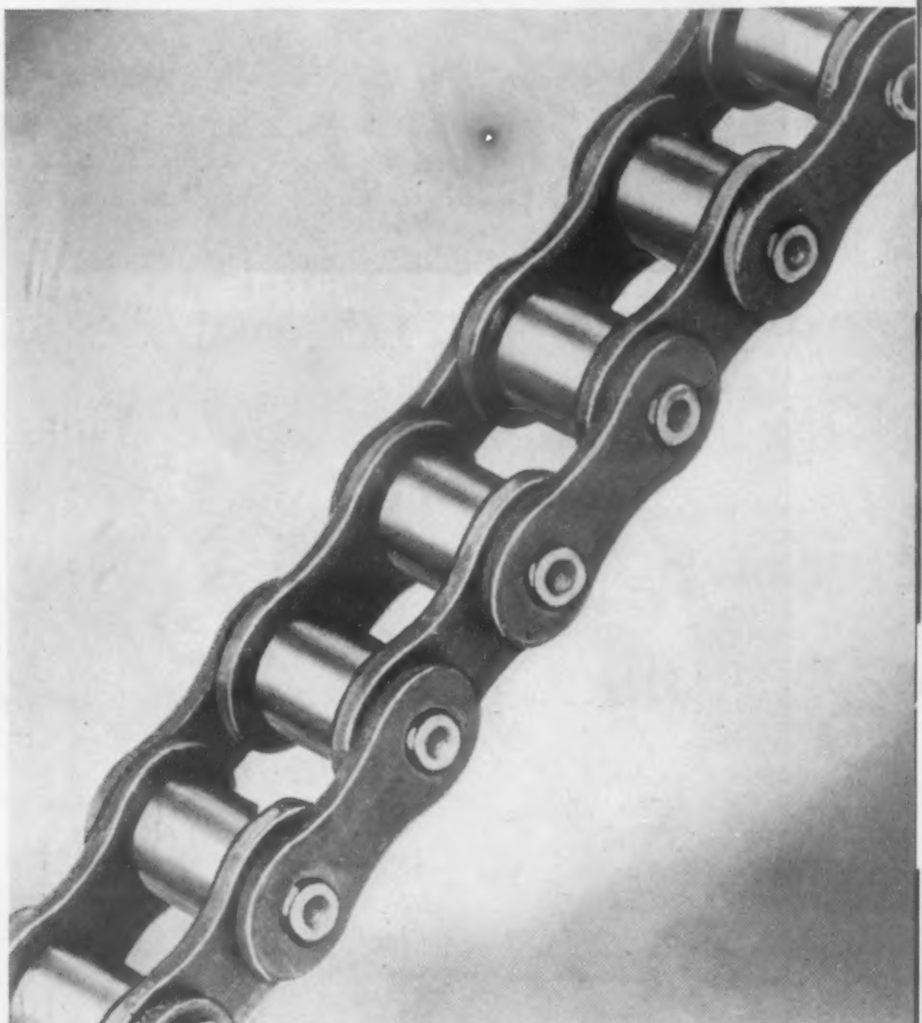
The first double-wall impact extrusion produced commercially in the United States is this U. S. Navy signal flare part. The part formerly required welding of two tube sections to an end plate. Impact extrusion does the job in a single operation at the Edgewater, N. J. works of the Aluminum Co. of America. The process permits simpler design with greater strength, smoother surfaces and lower manufacturing costs. Close tolerances can be held and the surface finish is extremely good. Aluminum alloys 2S and 3S are extruded cold, and parts up to about 3 in. in dia can be made at present. This size limitation is governed by the power of the extrusion press.

KEL-F-PESTLE

Use of Kel-F plastic as a pestle in a device that mechanically disrupts the cells of animal tissue has improved the efficiency of the unit which is used by an institution devoted to cancer research. The research institution has reported to its supplier, the Plax Corp. of Hartford, Conn., that Kel-F is resistant to the action of acids, alkalis and organic solvents used in this work. The transparent plastic can also be heat sterilized. Kel-F is particularly valuable as a substitute for glass where that material is too brittle or is not sufficiently resistant chemically. The device which uses the pestle is known as the Potter-Elvehjem homogenizer. The tissue is put in the tube with water or some other aqueous medium. The pestle is driven by a drill press or a high-speed motor, disrupting the tissue by the shearing force developed between the rotating pestle and the inner wall of the tube.





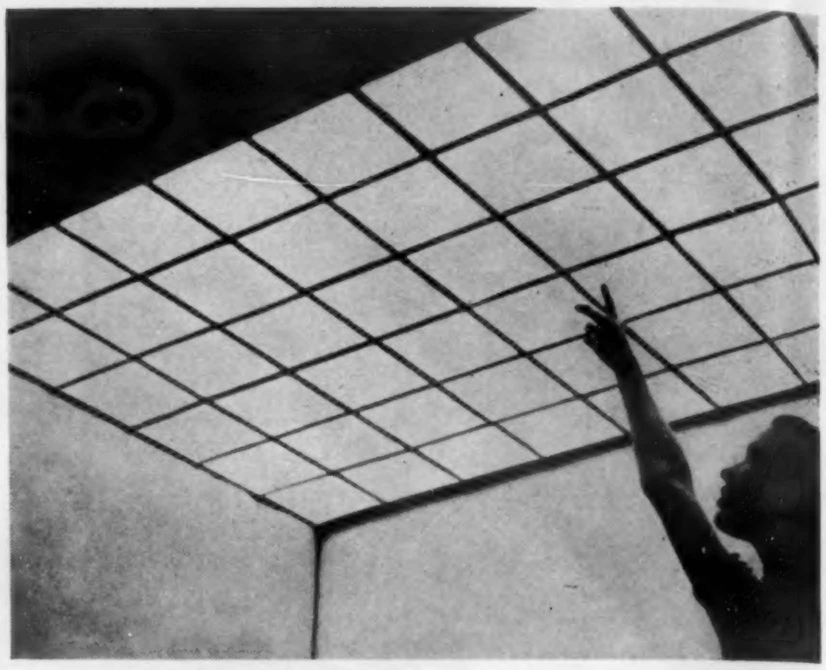


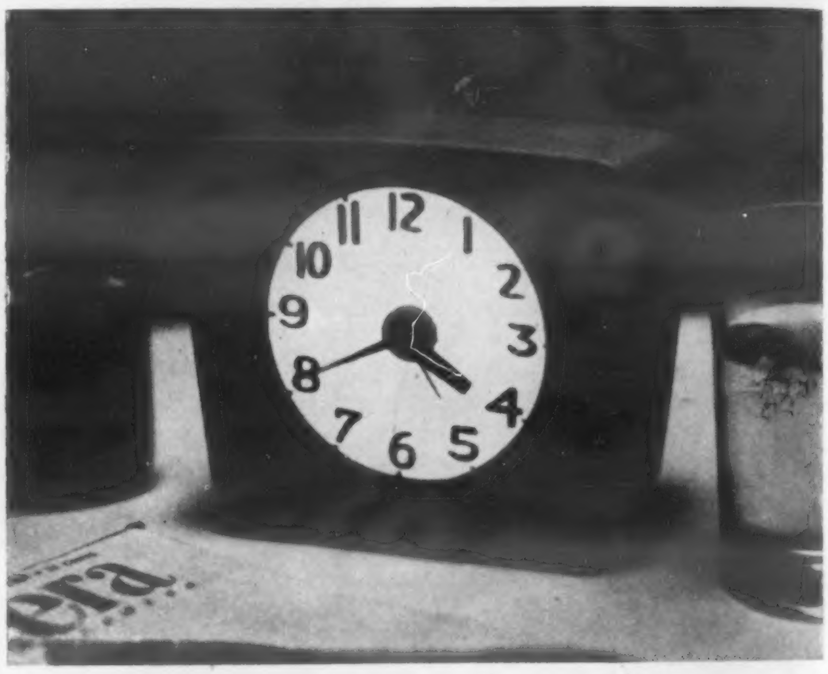
COPPER PLATING PROLONGS CHAIN PIN LIFE *The Baldwin-Duckworth Div. of the Chain Belt Co. combines several advantages in their method of copper plating the steel pins used in their roller chains. The pin is cut, machined, rough ground and tapered at the ends before plating (upper left). The copper plate is then ground off the shank, or middle section of the pin, leaving only the extreme outer parts of the pin ends covered (upper right). In the case hardening operation which follows, only the body of the pin (the bearing area or working surface in the assembled chain) absorbs carbon, leaving the ends comparatively soft. The body of the pin is given a finishing grind before the chain is assembled and the pin ends are riveted to the side plates. This method gives optimum hardness on the bearing surfaces and assures uniformly good riveting so that the pin does not rotate in the side plates. The soft pin heads permit easy cutting of the chain, and the distinctive copper plate adds to the appearance of the finished product.*

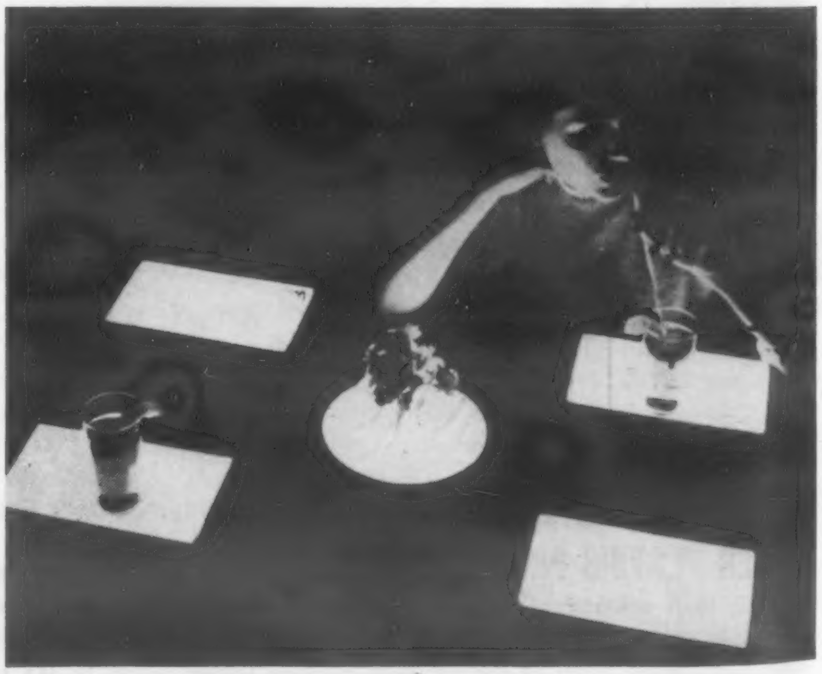
Materials at Work

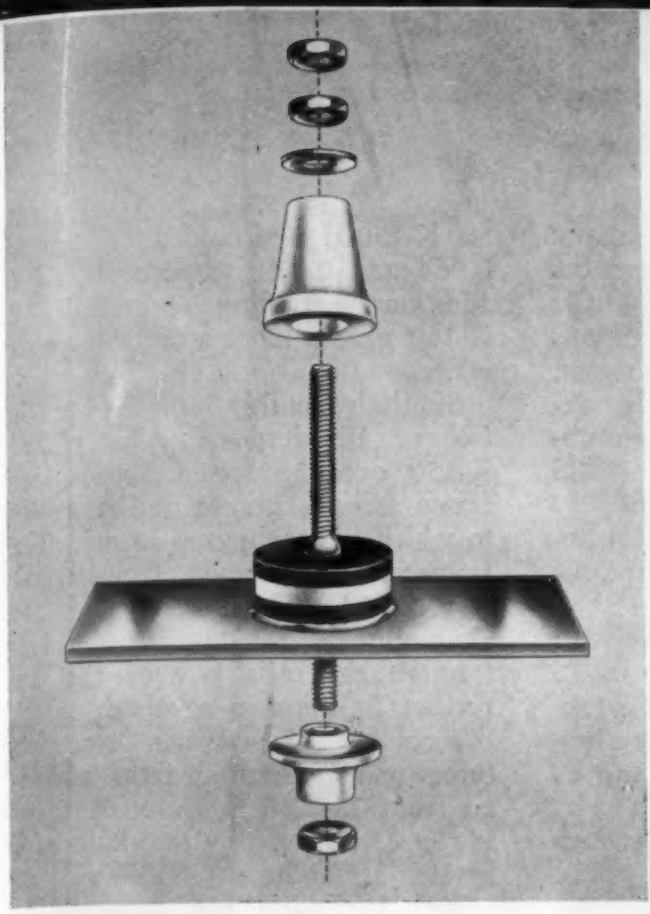
ELECTRO-LUMINESCENCE GIVES AREA LIGHT SOURCES

When certain materials are placed in a fluctuating electric field under the proper conditions, they are excited to luminescence and continue to emit light as long as the field is maintained. Sylvania Electric Products, Inc. has used this principle in its new Panelite material, which consists of sheets of electrically conducting glass on which a specially processed zinc sulfide phosphor-dielectric coating is placed and covered by a thin layer of vaporized aluminum. The two coatings add less than 0.01 in. to the thickness of the glass, and the heat generated by the process is extremely slight. The new area light panels can be operated on 110-v. a.c. for dials, clockfaces and similar surfaces. With the addition of a transformer to step the voltage up to 400 to 500-v., the light can be increased 20 times in intensity and is sufficient for low level illumination of rooms and public places. No air is evacuated in making the area lights, and there are no filaments to burn out; the average panel life is estimated at 1 to 5 years. Panelite is essentially a condenser, with one contact on the conducting glass, the other on the aluminum coating, and takes a leading power factor.

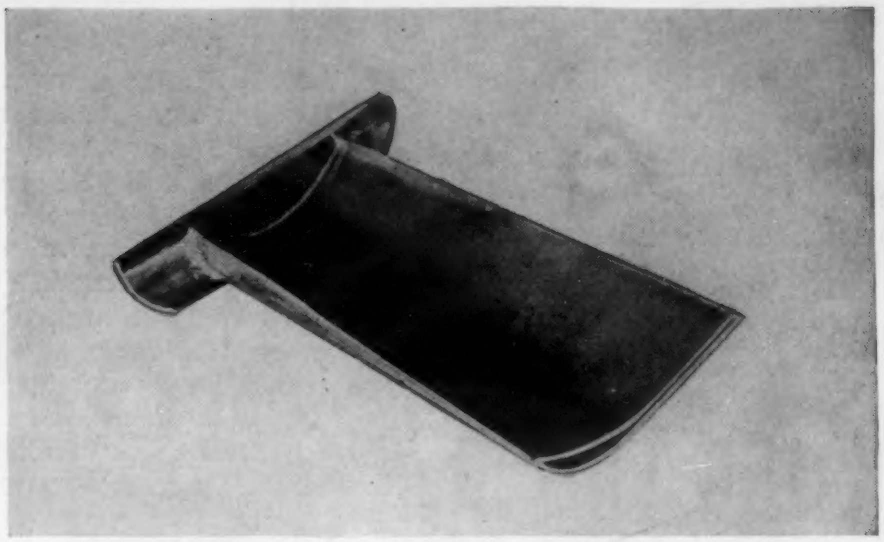








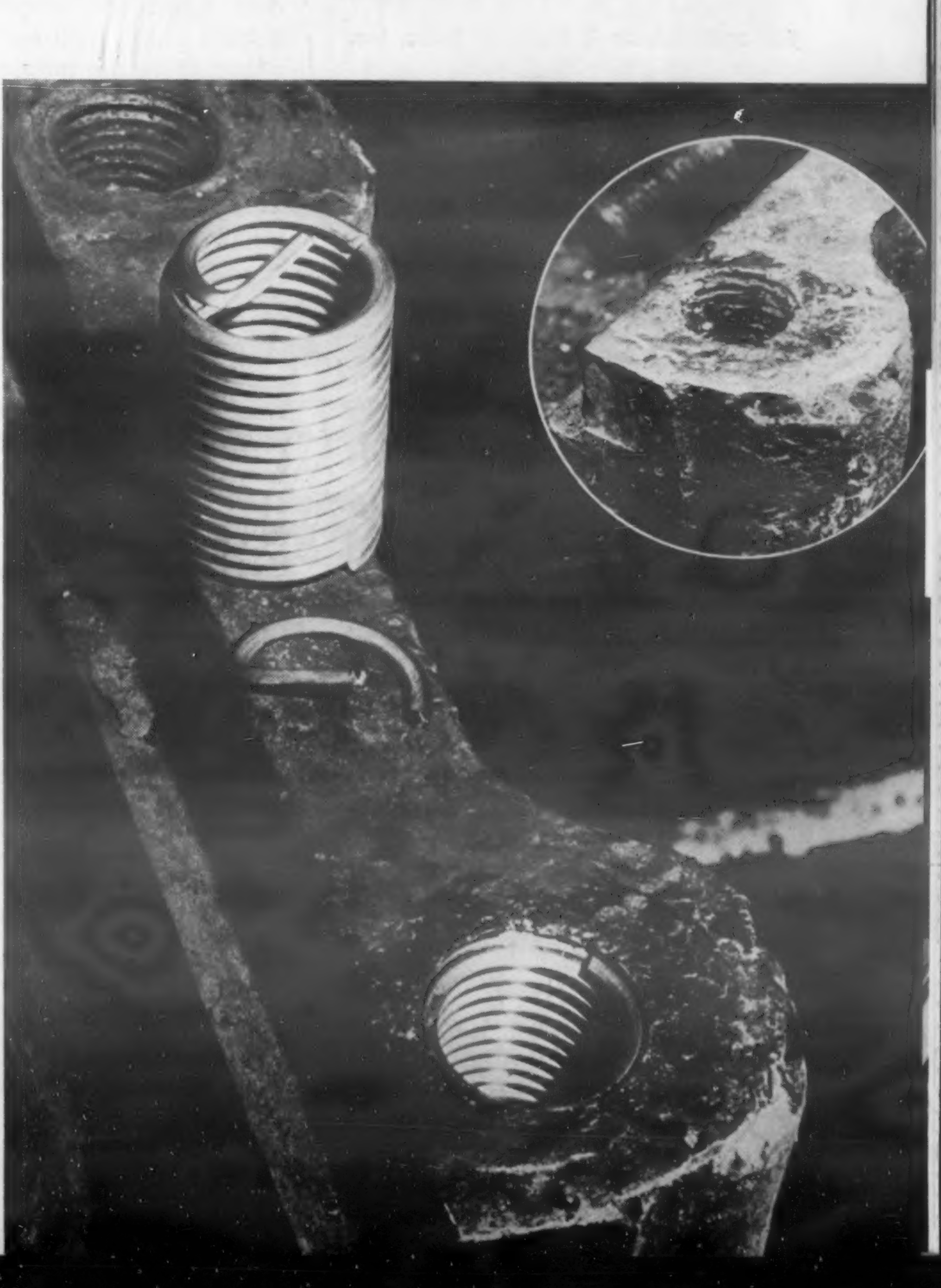
TEFLON-TO-METAL HERMETIC SEAL *The United States Gasket Co., Teflon Products Div., has recently succeeded in sealing fluoro-carbon resins to several metals to give a true hermetic seal. A recent example of applications of the process is this feed-through insulator, hermetically sealed. Various types of cylinders, printed circuits and metal faced Teflon sheets, rods and cylinders can also be designed for specific problems. Preliminary evaluation shows that the bond structure is micro-crystalline and that the seal gradually changes from a pure fluoro-carbon resin to a pure metal through its cross section. Because of the physical characteristics of Teflon, the seals can be made to withstand vibration, shock, high and low ambient temperature limits and thermal shock. They can be designed for a broad range of electrical conditions ranging from insulator, to semi-conductor, to low resistance conductor to radio shield.*



BRAZED JET ENGINE BLADE *The Wall Colmonoy Corp. of Detroit has developed a brazing alloy for applications in jet engines and other fields where the completed assembly operates at high temperatures —1200 to 1800 F. The new alloy also has excellent corrosion resistance properties. Trade-named Nicrobraz, it has an appreciable percentage of boron in addition to 65 to 75% nickel and 13 to 20% chromium. The 300 and 400 series stainless steels, vitallium, Inconel, monel, carbon steels, alloy and tool steels and metal carbides have been successfully brazed. Nicrobraz is supplied as a powder which begins to melt at 1850 F and flows freely in a pure dry hydrogen atmosphere at 1900 F. With stainless steels, a stable new alloy appears to form from fusion and alloying with the parent metal. Nicrobraz itself has an original hardness of Rockwell C-60, while the fusion alloy is Rc 30 to 35, with a much higher melting point than the original alloy, and with ductility, strength and corrosion resistance about equal to those of the parent metal.*

→

STAINLESS STEEL THREAD INSERTS *Repair operations on heavy electric motor castings are being speeded up by the use of stainless steel helical wire thread inserts made by the Heli-Coil Corp. of Long Island City, N. Y. New threads, stronger and more wear resistant than the original threads, are installed in 80% less time than conventional repair methods require, with cost savings as high as 60%. The new threads are installed by drilling out the old threads, retaping and installing the stainless steel coil to bring the hole back to the original threaded size. The coil insert, with a free diameter slightly larger than the receiving hole, is self-locking in position. The installed insert is properly positioned below the casting surface before its notched inserting tong is clipped off. Because the wire coils give higher thread-flank engagements, the threads in the repaired hole can carry 20 to 30% higher loads than the original threads.*



K-150 Fills Gap Between Established Aluminum Alloys

by DUDLEY T. ROSS,
Kaiser Aluminum & Chemical Sales, Inc.

This general-purpose alloy has properties lying between those of 3S and 52S, and features, among other things, good workability.

● A PROBLEM THAT FORMERLY faced many aluminum fabricators was the gap between the familiar alloys 3S and 52S. In applications for which 3S was not strong enough, the more expensive 52S was frequently over-strength. Forming problems were also encountered with 52S when deep draws were required.

The Division of Metallurgical Research of the Kaiser Aluminum & Chemical Corp. developed K-150 to provide a general-purpose alloy with properties lying between those of 3S and 52S. Yield strength and workability were emphasized in developing the complementary alloy, and its workability, finishing qualities, strength and economy have lead to its adoption for a variety of products.

The new alloy averages about 22% stronger than 3S in equivalent tempers. This differential is even greater in drawn parts because its work-hardening rate is considerably higher than that of 3S. Yield strength in parts made of K-150 has run as much as 40% greater than in identical parts of 3S, and some manufacturers have been able to reduce the metal gage by replacing 3S with K-150.

The possibilities for economy to be derived from use of K-150 are evident when the properties are considered along with cost: K-150 costs a cent more per pound than 3S (but is slightly lighter) and at least 3¢ per pound less than 52S in the same gages.

Some Applications

Strength was a major factor in the selection of 150S by the Spartan Aircraft Co. of Tulsa, Okla., in the production of window frames. The frame is a drawn pan with 2-in. radius in the corners and 7/8 in deep, varying in size from 9 by 32 in. to 13½ by 42 in. Spartan used K-150 in the 0 temper in 0.051 gage, and obtained a trouble-free draw, with very little springback on the straight sides. The sheet also work-hardens enough in drawing to give an exterior rivet pattern free from the excessive "dimpling" or "quilting" which had often been experienced in the use of 3S-0. K-150 in 0.040 gage is also used by Spartan to fabricate structural ribs which present a difficult forming operation because of the cambered exterior side of the channel section.

The G. M. Gibson Corp. of Bellevue, Iowa, also replaced 3S with K-150 for drain boards and the lid on its washer—going from 3S-H14 to K-150-H34 in identical gages, 0.064 and 0.032, respectively. The additional strength provided by K-150 gave a more acceptable product.

Similarly, Southeastern Tool & Die Co. of Birmingham, Ala., picked K-150 over 3S for a screen door frame section because of the strains to which it is subjected in use. The frame is roll-formed from 0.051 K-150-H34. The finish given the aluminum by the successive passes through the rolls is such that no further finishing is required.

Koolvent of Indiana, manufacturers of aluminum awnings, switched from 3S-H16 to K-150-H36 for louvers and structural stock to give greater strength, while 3S was retained for parts not subjected to severe loadings.

At the other end of the range, in several applications, K-150 has replaced 52S on a gage-for-gage basis, with substantial savings. One large television set manufacturer did this in a high-frequency tube shield and several other components, (Fig 2). Formability and adequate strength were the main requirements. 3S was good from the workability standpoint, but not satisfactory in yield strength, and 52S was, therefore, the standard. In making the change from 52S to the more economical K-150 the only modification in specifications was to increase temper from H32 to H34, which in K-150 was still formable enough for the purpose. Various gages of K-150 were used: 0.051 in the tube shield; 0.064 in the yoke clamp, the focus coil support, the lever plate and the yoke bracket support; 0.081 in the yoke bracket; 0.051 and 0.064 in the center brace. In some items H32 temper was used where the greater yield strength of H34 was not required.

Another case where K-150 replaced 52S in identical gages is in table and tray tops and shelves fabricated by Trimble, Inc. of Rochester, N. Y., for their infants' baths, play table and other household items. In the top the gage is 0.030. In first converting to K-150, Trimble increased the temper to H34. It was feared initially that this temper might cause difficulties in the draw around the perimeter, but it actually proved possible in later developments to use H36 temper successfully to produce an even better product by increasing dent resistance while still permitting fabrication without added failures because of the greater hardness. This top is produced in a one-stroke draw,

and Trimble succeeded in eliminating the necessity for trimming after the draw. The blank is pre-trimmed and then drawn into place. The part is finished by degreasing, an etch, a cold-water rinse, a nitric dip and second cold-water rinse followed by hot-air drying and lacquering.

The adaptability of K-150 to roll-forming has proved to be an advantage in numerous applications. Besides the screen door frame described above, such applications include: trim, weather stripping and moldings as produced by Protex, where K-150-H36 replaced 52S-H34 in 0.095 and 0.012 gage; ⅜-in. butt seam tubing roll-formed by Kaiser Aluminum from K-150-H18, 0.035 gage and supplied to television antenna manufacturers; trim section for busses roll-formed by Kaiser from K-150-H34 0.051 gage. The latter section replaced an extruded section previously used. The roll-formed section has not only provided savings on raw material but also enabled the bus manufacturer to reduce cost further because it has not been necessary to etch the roll shapes or polish them as heavily as the extrusions to achieve the desired finish.

Other applications which have used K-150 extensively include utensils, containers, trays, pans, gutters and downspouts, fan blades, pipe, lighting fixtures, vending machine parts, auto trailers, boats, furnaces and shoe eyelets.

Comparative Typical Properties of 3S, K-150S and 52S

	Ten. Str., Psi	Yld. Str., Psi	Elong., % in 2 In.
3S-0	16,000	7,000	30
K-150S-0	21,000	8,500	25
52S-0	28,000	12,000	25
3S-H12	18,000	17,000	10
K-150S-H22	23,500	16,500	13
K-150S-H32	25,500	21,000	9
52S-H32	34,000	27,000	12
3S-H14	23,000	22,000	8
K-150S-H34	28,000	24,500	6
52S-H34	37,000	31,000	10
3S-H16	26,000	25,000	5
K-150S-H36	30,000	27,000	5
52S-H36	39,000	33,000	8
3S-H18	29,000	27,000	4
K-150S-H38	32,000	29,000	5
52S-H38	42,000	36,000	7
K-150S-H18	33,000	31,000	4
K-150S-H19	37,000	35,000	3

(These two tempers, with K-150S-H38, are for flat parts that get little or no forming.)

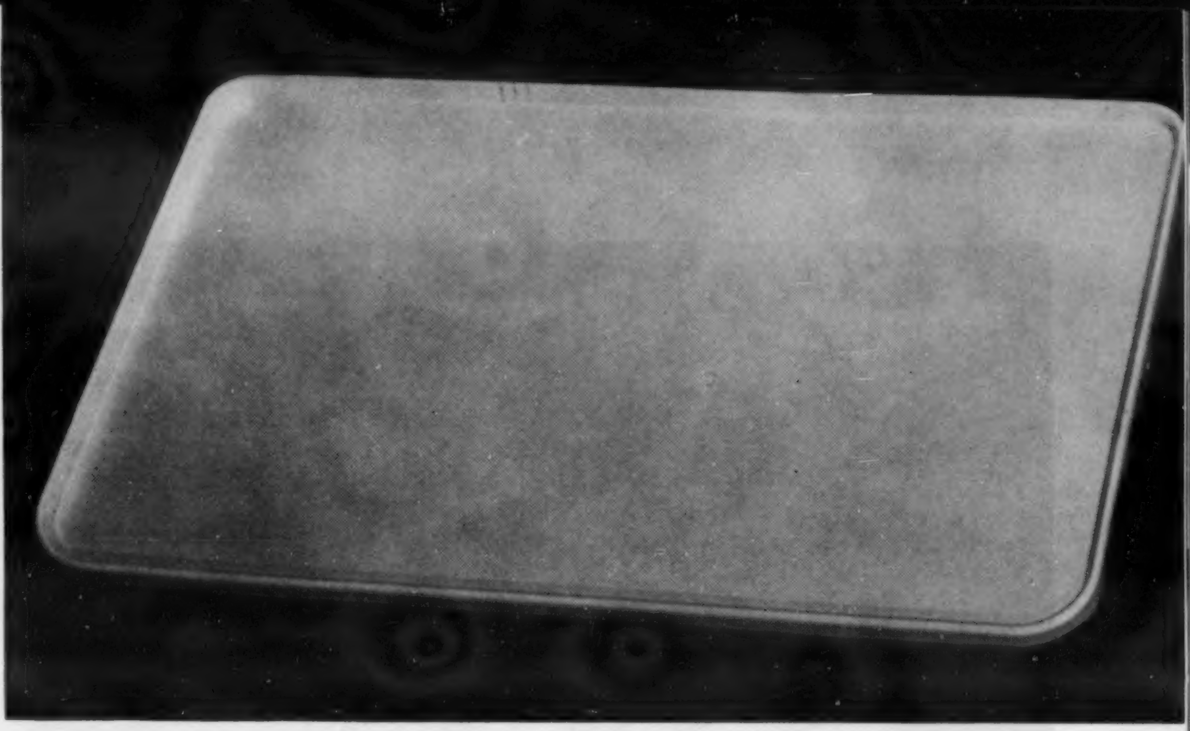


Fig. 1. Table top produced by Trimble, Inc., with one-stroke draw from 0.030 K-150. No trimming is required after the draw.

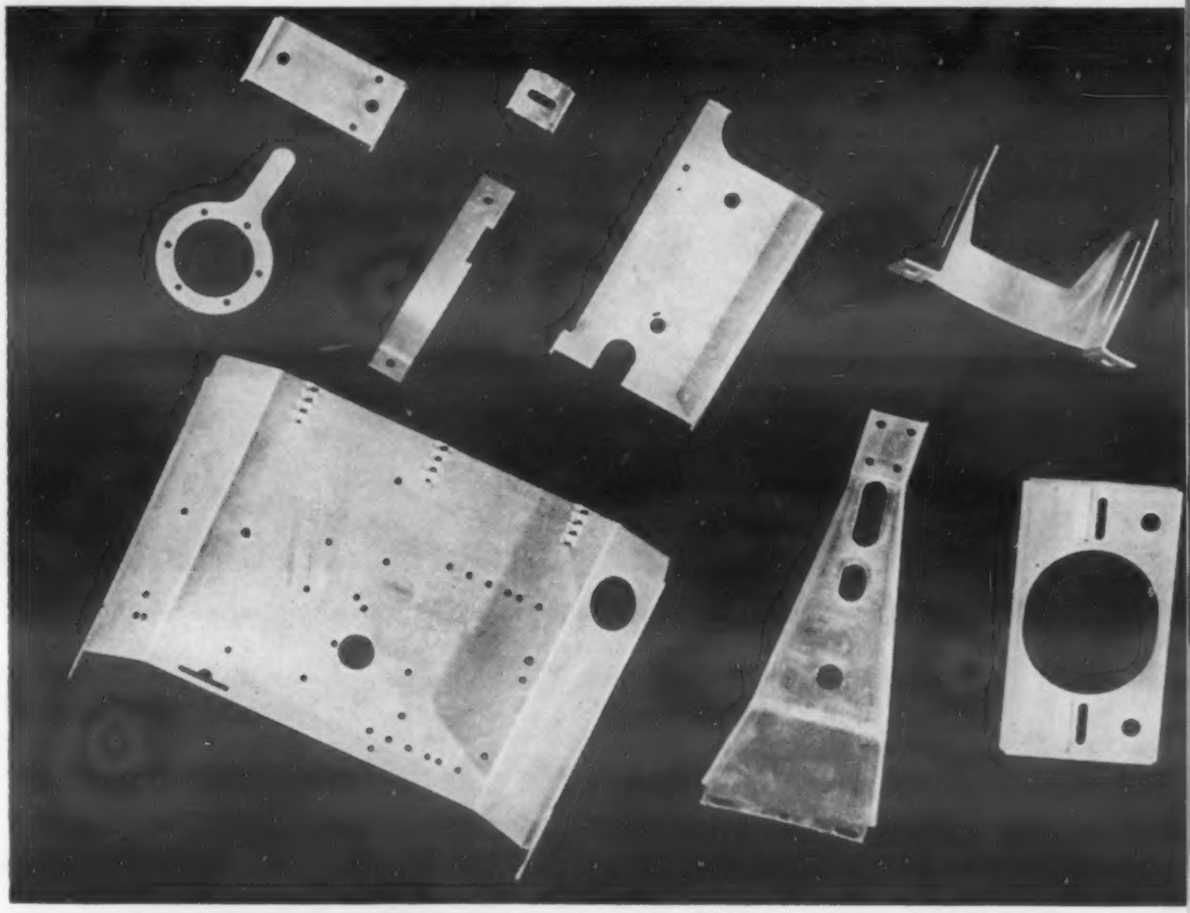
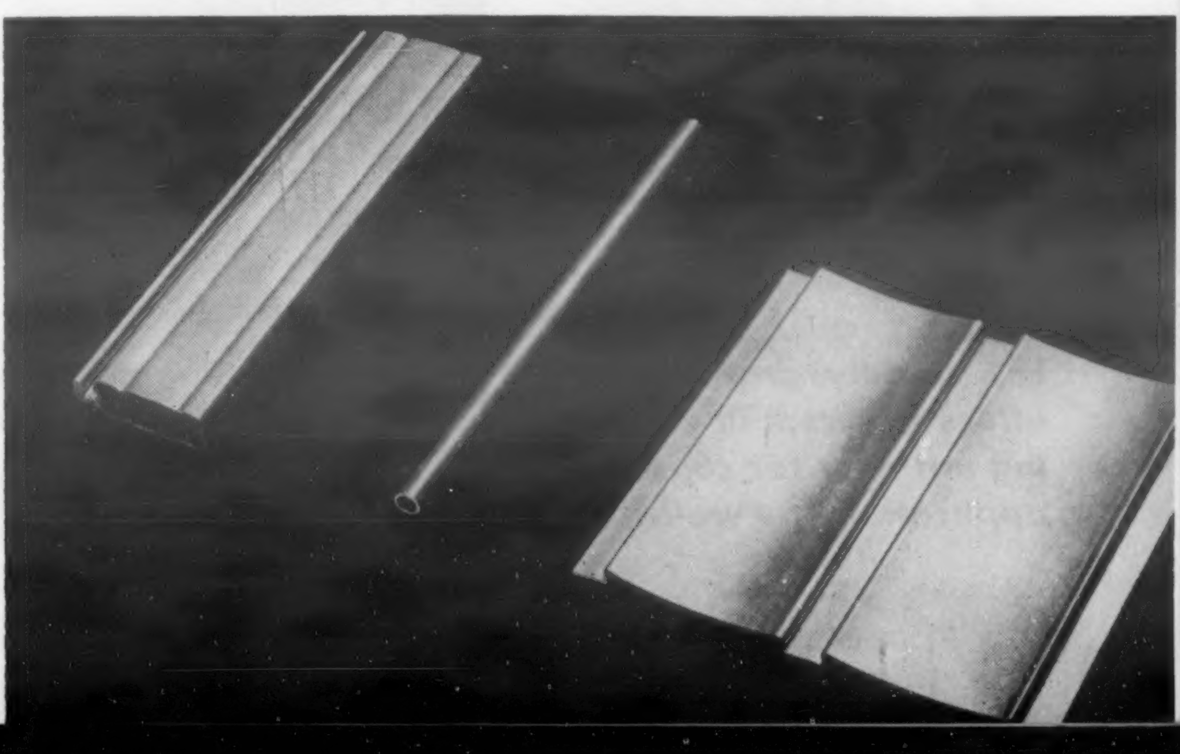


Fig. 2. Television tube shield and accessory parts, for which K-150 was substituted for 52S on gage-for-gage basis.

Fig. 3. Left to right: Screen door frame section produced by Southeastern Tool & Die Co.; ⅜-in. butt seam tubing for television antenna and bus trim section, both produced by Kaiser Aluminum. All three are roll-formed from K-150.



Dynel fiber, one of the newer synthetics, ready for spinning. (Carbide and Carbon Chemicals Co.)

New Synthetic Fibers Show Promise of Wide Use in Industry

by KENNETH ROSE, Western Editor, Materials & Methods

The rapidly growing family of synthetic fibers offers a versatile range of properties worth considering not only for consumer items but for industrial applications as well.

● WITHIN THE PAST SEVERAL decades the science of chemistry has modified various cellulosic substances to produce new synthetic fibers called the rayons. They consist of cellulose, obtained from purified wood pulp or cotton linters, that has been dissolved in a chemical solvent and then precipitated as continuous filaments by extruding through tiny orifices into a chemical bath. Because their properties can be controlled by the chemical processing and the size of the orifices, these synthetics immediately won an important position supplementing the natural fibers available to industry.

More recently wholly synthetic fibers have been produced that further expand the range of properties obtainable. While most of the public interest has been concentrated upon the use of these materials in consumer goods, and especially in clothing, they offer new possibilities to industry for such items as tarpaulins filter cloths, electrical insulation, chemical resistant work garments, reinforcing for fire hose, belting, as a laminating material for plastics, tire reinforcing, cordage and webbing. Some of the new fibers are produced by extruding filaments from a chemical solution of the material (dynel or Orlon), while others are made by melting the base material and extruding and cooling (nylon, Dacron, glass fiber).

The rayons are now well established, being second only to cotton in quantity used, and require only brief mention. Basically, they are of three types: acetate, cuprammonium and viscose. They can be modified physically or chemically to produce some variations in properties. They are characterized by rather low strength and by low wet strength; water absorption is usually high. Certain high-strength formulations possess a strength surpassing that of natural and other man-made fibers, however, and saponified types are available that have high water resistance and good wet strength. Chemical resistance of most types is not high; they are attacked by both acids and alkalies, but are fairly resistant to weak alkalies, such as would be found in soaps. They lose strength rapidly at temperatures below the boiling point of water. They possess a high luster unless a delustering process is used.

Of the newer synthetic fibers, none is chemically related to the celluloses. They are divided into the following groups chemically:

Vinylidene chloride—saran filament, produced from resins made by Dow Chemical Co.; Velon, trade name of Firestone Plastics Co.; other trade names by filament spinners.

Vinyl chloride acetate—Vinyon filament, produced by American Viscose Corp. from vinyl resin made by Carbide and Carbon Chemicals Co., a division of Union Carbide.

Polyethylene—Avisco PE, trade name for filament spun by American Viscose Corp.; other trade names by filament spinners.

Glass—Fiberglas, made by Owens-Corning Fiberglas Corp.; Vitron, made by Glass Fibers, Inc.; and fibers by Libbey-Owens-Ford Glass Co.

Acrylonitrile-vinyl chloride—Dynel, a copolymer made by Carbide and Carbon Chemicals Co., a division of Union Carbide.

Acrylonitrile—Orlon, produced by E. I. du Pont de Nemours & Co., Inc.; Acrilan, a product of Chemstrand Corp.

Polyamide—nylon, made by E. I. du Pont de Nemours & Co., Inc.; and by Chemstrand Corp.

Polyester—Dacron, made by E. I. du Pont de Nemours & Co., Inc.

For all of these fibers, the fiber itself is extruded as a *continuous filament* or a "tow." The filaments can be extruded in rather large diameter and used as such, or they can be extruded in small diameter and a number of them twisted together into a *multiple filament.* The filaments can be woven or knitted into a fabric or braided. If the tow (an extremely large cluster of filaments) is chopped into short lengths, the short pieces (*staple fiber*) can be used as a wooly mass (*batt*), matted into a *felt,* or spun into a wool-like *yarn* and the yarns woven into a fabric. Fabrics woven of continuous filaments are usually silklike, while the fabrics woven of yarns of staple fiber are cotton or woollike. Fabric woven of staple fiber is usually bulkier than that of continuous filament, with better thermal insulation but lower strength.

Saran and Velon

Dow Chemical Co. has relinquished its rights in the trade name Saran, which has now become a generic name for vinylidene chloride filament. Some of the outstanding characteristics of this fiber are good chemical resistance, high abrasion resistance, good strength properties with no loss when wet, and with strength maintained at temperatures to about 160 F for continuous exposure and to about 212 F intermittently. The resistance to acids, weak and strong, and especially to hydrochloric, is particularly good, and most alkalies have no appreciable effect upon the material. Ammonium hydroxide attacks the fibers, however. Automobile and aircraft upholstery, screen cloth, filter cloth, cordage and webbing are important items produced from vinylidene chloride polymers extruded as filaments.

Vinyon

Vinyl chloride acetate fibers are strong, have excellent chemical resistance, are slightly less heat resistant than the saran fibers, maintain strength when wet, can be used both as continuous filament and as staple fiber, are resistant to sunlight and weathering, and may be flame resistant if compounded for such property. Fabric woven of vinyl chloride polymers and copolymers, especially the acetate, are used as chemical filter cloths, in the depressed areas of sculptured carpets, or for severe outdoor service.

Avisco

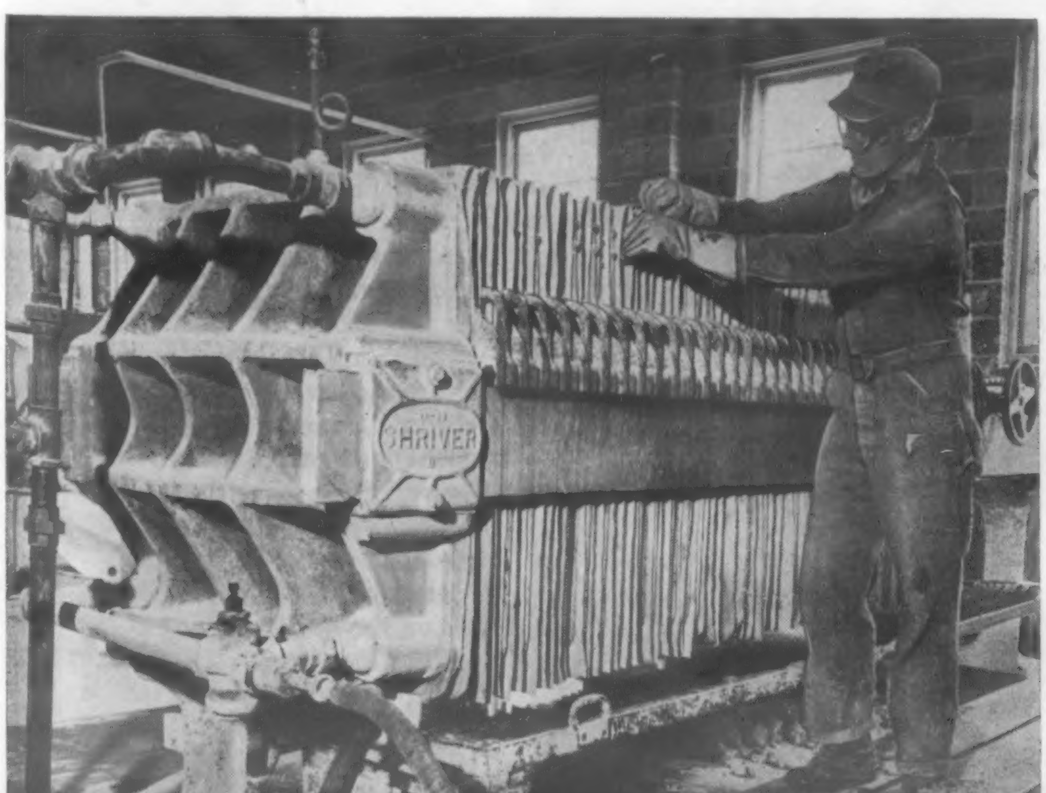
Polyethylene mono-filament is produced by several companies, and finds some use as an upholstery material for busses, and for passenger car seat covers. It has extremely high chemical resistance, but stretches considerably under load.

Glass Fibers

Glass fibers were first produced in Germany during World War I as a substitute for asbestos, but have become industrially important within the past two decades. Glass fiber is produced both as continuous filament and as staple fiber, and because of its complete fireproofness, nonabsorption of water, and high acid resistance, except to hydrofluoric and hot phosphoric acids, it is an important laminating material, a heat and electrical insulator, a filter medium, etc. The fibers are among the strongest known, but they must be woven with proper understanding of their characteristics to obtain maximum strength in fabric. Unless protected by a dressing, the overlapping fibers tend to abrade each other and to fail short of their theoretical strength.

Dynel

A copolymer with unusual chemi-



A plate and frame filter press used by Foote Mineral Co., in which Dynel proved considerably more economical than other fabrics. (Carbide and Carbon Chemicals Co.)

Typical Properties of Some Synthetic Fibers

Fiber Type	Trade Name	Ten. Str., Psi, 70 F & 65% Rel. Humid.	% Str. when Wet	Elong., %, 65% Rel. Humid.	Resistance to Outdoor Exposure	Str. Loss, Temp. F	Sticking Temp., F, or Softening Temp., F
Acetate Rayon	Celanese, Lanese, Avisco, Estron Acele	20,000–30,000	50–75	25–50	Loses strength somewhat	195–225	400
Cuprammonium Rayon	Bemberg	30,000–40,000	60	10–20	Good	....	....
Viscose Rayon	Avisco, Cordura, Chardonize Narco, Delray, Briglo, etc.	30,000–75,000	45–65	10–30	Yellows slightly	....	....
Glass	Fiberglas Nitron	250,000–300,000	100	2.5–3.0	Excellent	675	1375–1550
Vinylidene Chloride	Saran Velon	25,000–60,000	100	20–30	Excellent	160–200	160–250
Acrylonitrile Vinyl Chloride	Dynel	60,000–70,000	100	30–35	Excellent	300–350	240
Acrylonitrile	Orlon Acrilan	60,000–80,000	100	10–35	Excellent	160–275	450
Polyamide	Nylon Chemstrand	65,000–120,000	85–90	15–25	Excellent	285	480
Polyester	Dacron	85,000–95,000	95	9–12	Excellent	300	460

The high resistance of nylon to alkali and Orlon acrylic fabric to acids makes them important in filter fabrics. (E. I. du Pont de Nemours and Co., Inc.)

cal resistance is the acrylonitrile-vinyl chloride material produced as continuous filament or staple fiber, and used for filter cloths, acid resistant clothing, valve and flange covers, nets for use in laundries and dye houses, blankets and men's socks, under the generic name Dynel. It can be blended with cotton, rayons or wool for general garment applications. The all-Dynel fabric will resist attack by strong acids such as hydrofluoric acid and nitrohydrochloric acid, and possesses excellent resistance to such strong caustics as sodium hydroxide and potassium hydroxide also. Strong chromic, nitric and sulfuric acids when hot may attack some fabrics, however. The fiber has good strength, which is unaffected by wetting. When the fiber is stabilized, the strength is maintained well at temperatures above the boiling point of water. An interesting new use of Dynel pile fabric that resembles lambswool is in paint roller covers.

Orlon and Chemstrand

A group of synthetic fibers, chemically related to the acrylonitrile synthetic rubbers, has very recently come into commercial production. Orlon, produced by du Pont, and Chemstrand, a product of Chemstrand

Corp., which is a joint subsidiary of Monsanto Chemical Co. and American Viscose Corp., are acrylonitriles of closely related composition. Somewhat different solvents are used by the companies in making up the solutions for spinning.

The outstanding advantage of the acrylonitrile fibers over earlier synthetics such as nylon is in increased resistance to deterioration by sunlight and weathering, along with better resistance to acids. Tensile strength is good, and is maintained to the extent of about 90 to 95% when the fiber is wet. Resistance to acid attack is good, especially to strong mineral acids. Alkalies will attack the fibers, however.

Very recently du Pont announced a special process for its Orlon fiber to make it resistant to burning at temperatures as high as 1400 F. No details of the process have been revealed, and to date fabric has been prepared experimentally only. The treatment does not consist of adding a "snuffer" to the fiber, it was announced, but is performed upon the woven fabric, which is converted to a new and different chemical compound. The fabric after treatment is no longer Orlon, but a chemically distinct material, with about the same tensile strength as that of wool. Fire resistant clothing for plane crews, firemen and others; nonflammable theatre curtains; and fire blankets for ships and aircraft have been suggested as possible uses.

Acrylic fibers are used for industrial filters, both wet and dry; for cordage, awnings and similar articles that are exposed to sun and weather; for acid resistant garments. It has possibilities for such uses as anode bags, auto tops, electrical insulation, rubber laminates and diaphragms.

Nylon

The du Pont Co.'s nylon indicates the interesting family of polyamide fibers and molding materials. Chemstrand Corp. has recently been licensed to produce nylon. Nylon was the first of a steadily lengthening series of wholly synthetic textile fibers, and is still one of the most important of that series, if only for the fact that it is now generally available in commercial quantities. It has been pointed out that the newer synthetics supplement rather than supplant nylon. Nylon is slightly inferior to the newer acrylonitriles in resistance to sunlight and weathering, and in acid resistance, but it is resistant to alkalies which attack the acrylics. Nylon is stronger than the acrylics, especially in the high-tenacity types, and maintains about 90% of its strength when wet. It is used for hoisery, cordage, tarpaulins, as a reinforcing in aircraft tires, luggage, upholstery fabrics, fish lines, carpets, etc.

Dacron

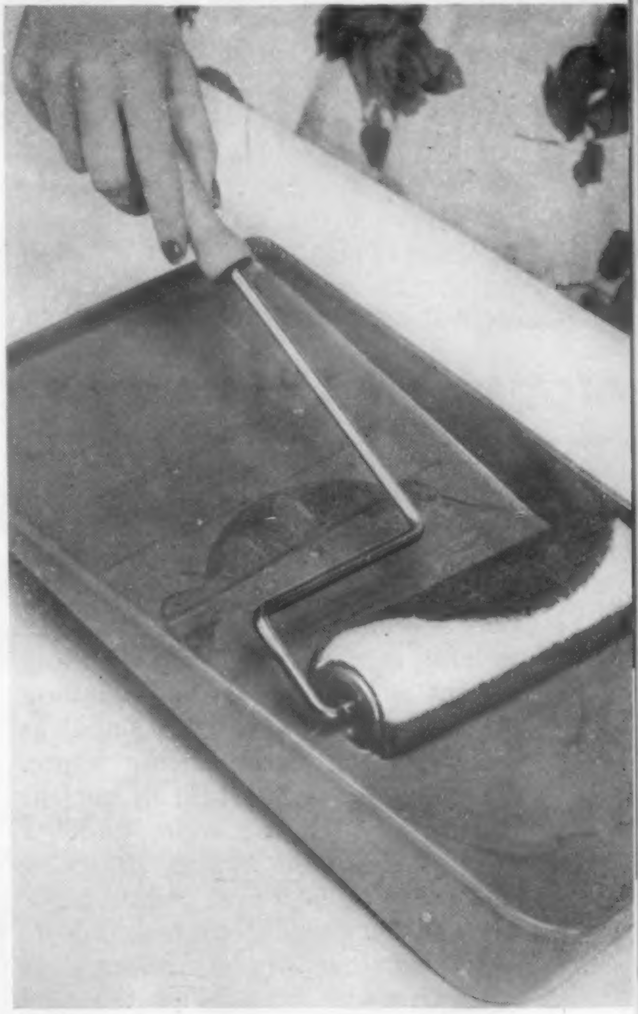
One of the newest synthetic fibers to be announced as in commercial production is the polyester offered by du Pont under the trademark Dacron. This was designated Fiber V during its test period. It has improved resistance to deterioration by sunlight and weather, good strength wet or dry, good resistance to wrinkling wet or dry, and will withstand higher temperatures than the acrylonitriles. An added feature is its light weight, which, combined with its good strength properties, make possible weight savings in such items as fire hose coverings. It has the advantage over nylon of resisting stretching under load. Dacron is too new to have established itself widely in applications other than wearing apparel where its heat setting, stain resisting and long wearing qualities are important, but it has been suggested for belting, cordage, electrical insulation, laminating, filter cloths and work clothing. It has good acid resistance, but only fair alkali resistance. Alkali resistance is good at room temperature, but the fiber is attacked by hot solutions. It is produced in both filament and staple fiber form.

Bristle Fibers

A group of fibers with special properties, and including members of a number of chemical types, is the bristle fibers. These include fibers for paint brushes, toothbrushes, hair brushes, various types of cleaning brushes for industry, bristle wheels, and other cleaning devices. Most of the bristles used in toiletware are nylon, extruded as a heavier continuout filament than is used in textiles, and offered under its own name, or under a trade name of the brush manufacturer, such as Exton or Prolon. Coarse vinyl chloride fibers are used in industrial cleaning brushes, and vinylidene chloride and some of its copolymers are in this field also.

A bristle especially intended for paint brushes is a tapered nylon filament. Another is a synthetic fiber which is a modification of a natural material, produced by Pittsburgh Plate Glass Co. and sold under their trade name as Neoceta. It has the unusual combination of equalling or exceeding the paint-carrying ability of natural Chinese bristles, and of wearing at about the same rate, so that the synthetic bristles can be used alone or in combination with natural bristles. The value of some of the newest synthetics as bristle fibers has not as yet been fully explored by test.

Of interest to the garment industry is the announcement by du Pont of production of synthetic fur-like fabrics from several of the new fibers. Nylon, Orlon, Dacron and Dynel



Dynel pile fabric used in a paint roller. (Carbide and Carbon Chemicals Co.)

have been processed into these new fabrics, and a new type of crimped viscose rayon, tentatively known as Fiber E, has likewise been used for the fur-like materials. They may be of interest for military uniforms for cold weather, as well as for low-cost "luxury" wear.

Fibers are frequently blended when spun or mixed when woven, using both synthetic and natural fibers to obtain a balance of properties. Finishes and dressings used in preparing the fibers for weaving, in dyeing, or in the fabric, may materially alter the properties of the textile.

Resistance Welding of Aluminum Steels and Coated Metals Improved by Slope Control

by F. L. MILLER, Controls Div., General Electric Co.

Welding heat applied gradually at beginning of the weld by use of a slope control increases production and permits successful welds on materials not previously considered practical.

● SLOPE CONTROL IS A noteworthy improvement in resistance welding that makes possible satisfactory welds on metals which were previously welded only with extreme difficulty. In addition, it offers other advantages, such as longer electrode life, reduced electrode pick-up and increased production.

Stated simply, slope control involves an electronic attachment to the controls which allows the welding heat to be applied more gradually than is possible with conventional resistance welding controls. Thus, the welding current is built up at the beginning of the weld at a definite slope, as shown in the accompanying figure.

Ordinarily, the amount of current flowing through the weld, under a given set of conditions, is controlled by the setting of a heat control rheostat on the welding control proper. This rheostat setting determines, during each cycle, the point in the supply voltage wave at which the power tubes are allowed to conduct current.

The addition of slope control introduces two more settings. One rheostat performs much the same function as the heat control rheostat in the control proper, except that it determines the point in the supply voltage wave at which the tubes are allowed to conduct current *at the beginning of the weld.* As weld current cycles elapse, the tubes are allowed to conduct more and more current until they pass the amount determined by the heat control rheostat proper. The *rate* at which this gradual increase in current occurs during a given weld is controlled by the second setting on the slope control.

If an operator were able to turn the dial on the heat control proper from the desired setting at the beginning of the weld, and at the correct rate to the desired setting at the end of the weld, all within a period of a few cycles, he would then be doing what slope control does for him.

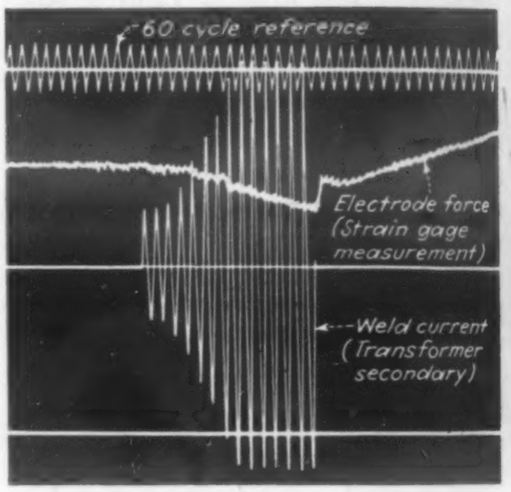
Slope control permits satisfactory welds on metals which were previously welded with extreme difficulty. Specifically, slope control offers these known advantages:

1. Increased production in aluminum welding. Longer electrode life. More welds between electrode cleanings.
2. Increased production in welding of plated metals. Less splatter. Reduced electrode pick-up. Improved corrosion resistance.
3. Permits single-phase welding of scaly steel.
4. Reduced transients in power supply and welding transformer.

Successful Applications

The above advantages can best be demonstrated by examples of the application of slope control to several different welding problems.

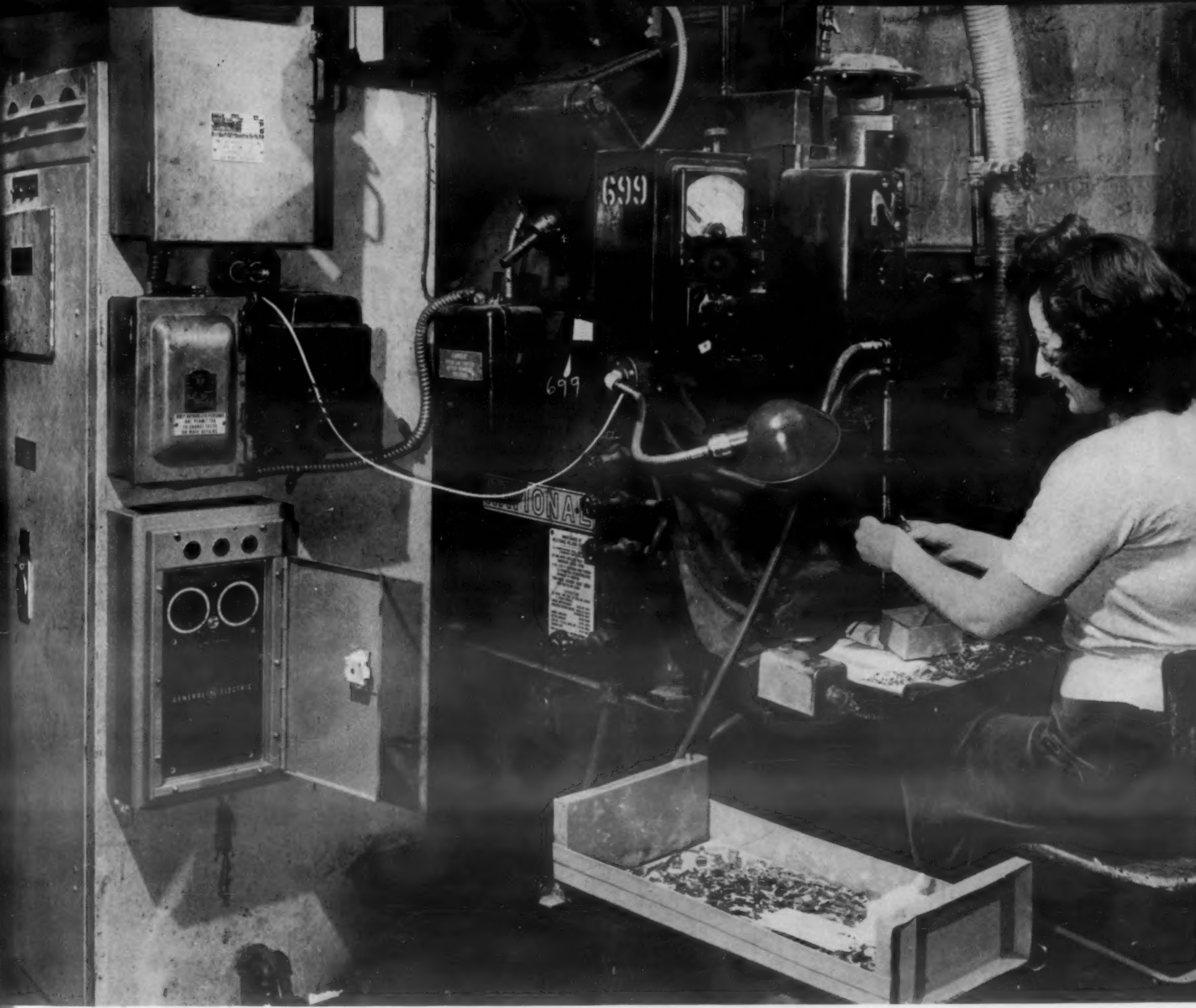
At the Lynch Brothers plant, Pine Meadows, Conn., a contract required welding two pieces of soft Alclad (0.064 in., 24-SO aluminum) to meet ANW-30 Specifications. Six standard single-phase welders were previously equipped with synchronous control. At the best operating settings without slope control, it was possible to obtain only 52 welds without cleaning the electrodes.



How slope control works. Note gradual weld current rise during beginning of weld cycle.

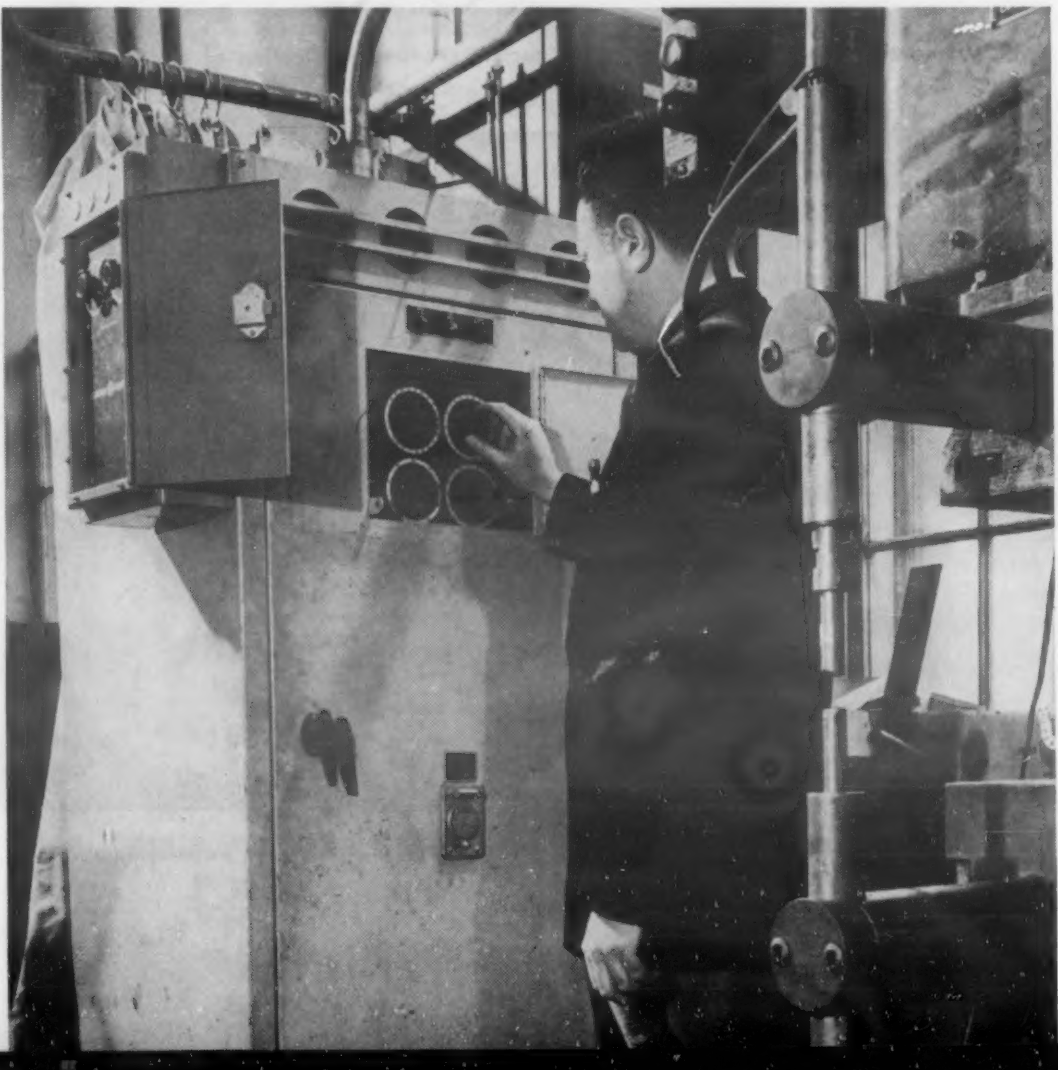
The addition of slope control immediately increased this figure to a minimum of 800 spots between cleanings. These results were consistently obtained over an observation period of ten weeks, two shifts, at an average of 9000 spot welds per hr. This is a typical case of increased production on aluminum with longer electrode life and more welds between electrode cleanings.

The General Engineering Laboratory, General Electric Co., attempted to seal off a $\frac{1}{4}$-in. dia stainless steel tube having a 40-mil wall thickness. The only satisfactory means of accomplishing this was to add slope control to the existing equipment because the sealed end had to be gas tight and successfully hold less than one micron of vacuum. Results from other welding procedures produced satisfactory seals at a 50% reject rate, while slope control, when added to the equipment, allowed successful welds with less than 5% rejects.



Slope control (shown mounted on side, lower left, door open) was added to this spot welder used on small stamping.

Addition of slope control (mounted upper left) makes possible longer electrode life and reduced electrode pick-up.



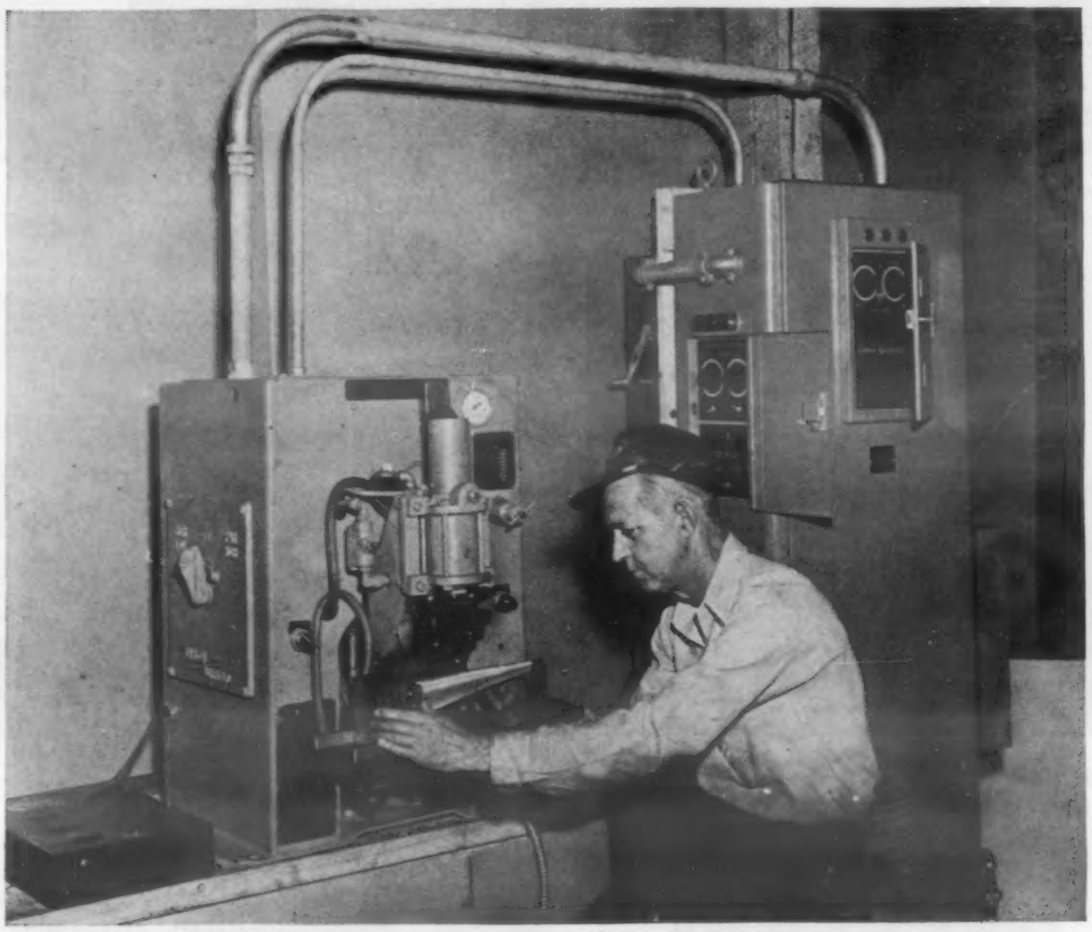
A Navy specification type overload relay requires that a contact tip and spring be welded together. The contact is a steel-backed silver tip. The spring is a short flat length of chromium-plated beryllium copper. The chromium plating must not be disturbed by the welding process. Since it must provide a smooth, long-wearing surface over which a bimetallic strip rides, standard resistance welding equipment produced only limited quantities of assemblies with satisfactory weld strength and surface smoothness. Slope control was applied here successfully. Examination of the resultant weld nuggets showed that they are consistently strong, contain streamers of chromium plate, and that the plating around the welds is not disturbed.

An example of the successful single-phase welding of scaly steel is the welding of 1/4-in. hot-rolled steel at Kehrig Manufacturing Co., Detroit. The two pieces to be

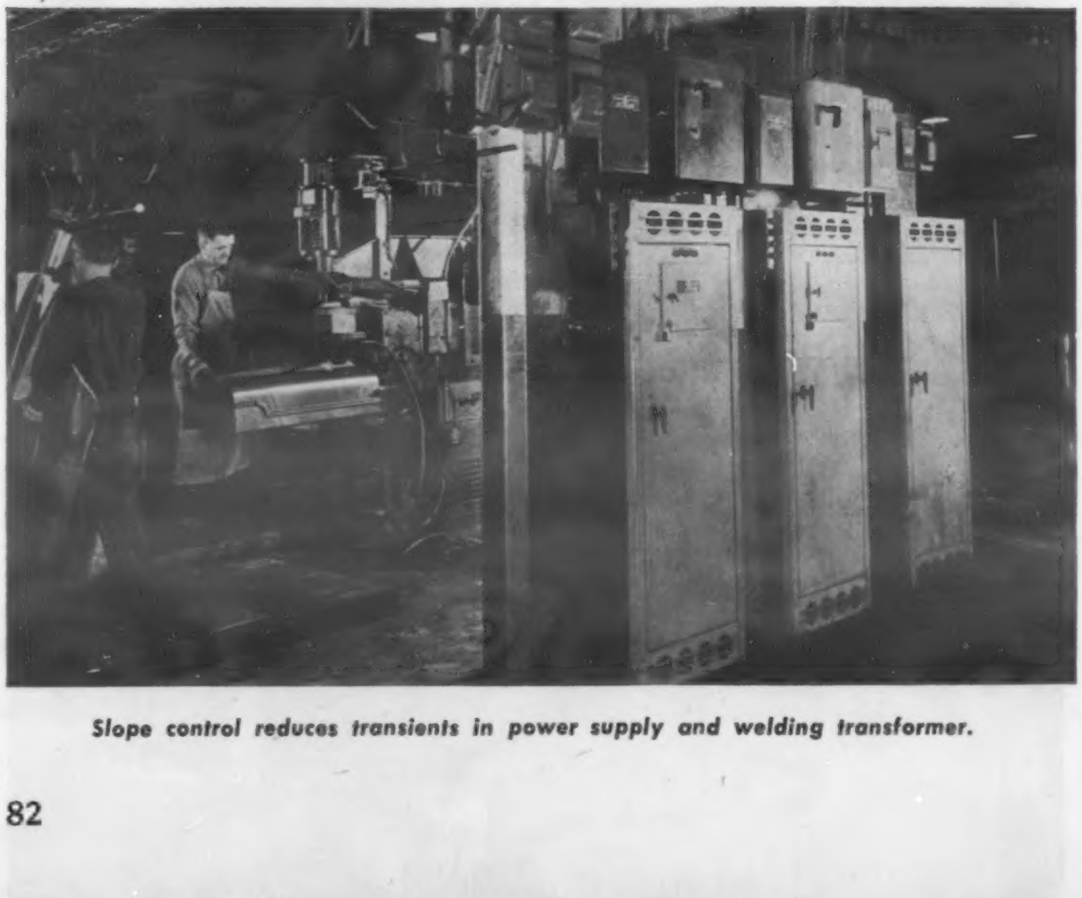
welded were to form sea wall barriers. The problem was to weld the pieces together without removing the scale, since in this case, it was known that the scale would retard further corrosion.

The contract did not permit a capital expenditure of three to four thousand dollars for a new machine. A welding machine with non-synchronous control was available, but not effective. The addition of slope control allowed the equipment to produce satisfactory welds and the range of the welding machine was thereby greatly extended by slope control.

At the Kelvinator Plant, Detroit, a trial slope control was purposely applied on long production runs to eight different machines selected because of the difficult materials they were handling. Two of these machines were welding galvanized steel, two were making difficult projection welds, and four others were welding heavy gage steel which caused serious disturbances to the power supply system. The results with slope control were rewarding.



A 20-kva welder using slope control to permit gradual application of welding heat.



Slope control reduces transients in power supply and welding transformer.

For example, a ring projection weld in a ½-in. valve had been discontinued because of 10% leak rejects. By adding slope control, the valve was welded with less than 1% rejects due to leaks.

In welding ⅛-in. steel, the kva input varied 85% between successive apparently duplicate weld conditions. These welds were made with synchronous control and measured with an oscillograph. When weld conditions were again duplicated, except with the addition of slope control, there was less than 10% variation in kva and, at the same time, the weld quality was greatly improved by the slow rise of current.

Welds on galvanized steel samples using slope control successfully passed the fourth week of brine test when this paper was prepared. The corrosion resistance of the weld was still as good as the plated material.

At the plant of the Ludlow-Saylor Wire Co., St. Louis, one of the many welding operations is that of line projection welding brass mesh. Certain sizes could be welded with standard synchronous control, but welding a 100 by 69 mesh made of 4½-mil wire was much more difficult. Slope control in this case gave uniform fusion and eliminated the holes appearing in the mesh at the weld.

The City Auto Stamping Co., Toledo, has more than 300 welding machines and controls installed. This concern produces International Harvestor tractor engine hoods requiring projection welding. Recently International Harvester introduced a quality control program, causing many engine hoods to be rejected because of weld splatter. Therefore, it was necessary to employ three men to polish the parts in order to get acceptance under this program. For ensuing production, slope control was introduced. The result was that metal expulsion was so greatly reduced that the polishing operation was no longer necessary to obtain acceptance of the hoods.

These case histories are typical. Production men have found that slope control is an inexpensive addition to old and new resistance welding installations. It has reduced reject rates, increased production speeds, expanded the versatility of installed equipment, and permitted successful welds on materials not previously considered weldable from a practical standpoint.

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Typical of the military uses of die casting are these zinc fuse noses which are produced by Rupert Die Casting Co. at the rate of 2700 per hr per machine.

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application.

Die Castings

by T. C. Du Mond, Editor, Materials & Methods

The inherent advantages of die castings, plus the widening list of alloys from which they can be made, are responsible for the steadily increasing application of this metal form. In this concise, 16-page manual we present pertinent facts about die castings, including:

- ***Methods of Production***
- ***Materials of Which Die Castings Are Made***
- ***Comparisons of Die Castings and Other Fabricated Forms***
- ***Important Design Principles for Die Castings***
- ***Finishing of Die Castings***
- ***Where Die Castings Are Used***

Die castings, or as they are known in England, pressure die castings, have been produced for a period of roughly 100 years, although the processes and products as we now know them did not come into being until early in the twentieth century. Now die castings are used in every conceivable type of product, and their use is being extended every day as improved alloys are developed and die making practices are perfected.

In the early days of die casting, there was a limited range of alloys from which parts could be made. Tin and lead and their alloys were the only metals used. Next came zinc alloys and, some time later, aluminum alloys began to be used for die castings. In subsequent years, brasses and magnesium came into the picture to offer their own particular properties. Today zinc and aluminum alloys are used for the greatest bulk of die castings; magnesium is becoming more important where lightness is an advantage, and brass is finding wider use as better die steels become available.

Die casting is the fastest of the casting processes, and is generally used where speed and economy are essential. For practically all uses the castings can be used essentially as they come from the dies, after a simple trimming operation which removes gates and flash. As a high production method, die casting ranks with stamping, die forging, plastic molding, powder metallurgy and screw machine production where large quantities of identical parts are required.

Because die castings cannot be made of iron and steel, they are excluded from many uses. Their only other serious limitation is in the size of the part which can be die cast, or, more accurately, the weight of the part. Entire automobile grilles are being die cast in one piece, as are the interior of autombile doors. At the other extreme, parts that are as small as zipper teeth can be made as die castings.

There have been no radical changes in die casting procedures during the past decade. The changes have been in the products themselves, and in the attitude of industry and the public toward them. In the automotive industry, for example, die castings are being used for parts where once only steel or cast iron would have been considered. World War II proved that die castings could be used for many items of armament with consequent savings of more critical metals than those used in the die castings.

Die castings that are extremely complex in design are now becoming everyday jobs, and the knowledge of die action, gating, metal flow and other critical factors become greater. In the following pages we shall discuss the various methods of producing die castings, the materials which are most frequently used in die castings, advantages and limitations of these metal forms, and compare them with products of competitive production methods.

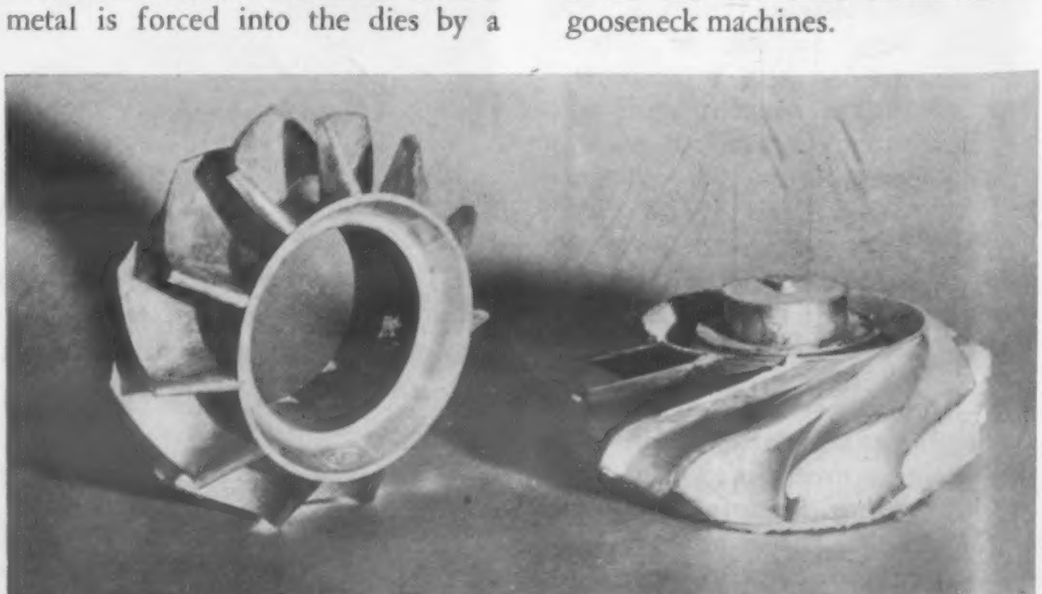
Methods of Production

As can be inferred from the name die casting, parts produced by the method attain their shapes through metal being forced into dies by air or hydraulic pressure. Dies are made in two sections: an ejector section, which usually contains the greatest portion of the cavity, and the cover section, which completes the closure and contains, generally, some of the cavity. The ejector section of the die is usually attached to the movable platen of the die casting machine, while the cover section is held by the fixed platen, which is generally located close to the metal pot. When a shape is being cast, the two die portions are locked together hydraulically, or mechanically, to prevent them from separating when casting pressure is applied.

Dies can have from one to a score or more of cavities all of which are filled in a single shot. If all cavities are duplicates, the dies are called multiple-cavity. If the cavities are different, the die is called a combination type. Some machines are equipped with holders for two to six small unit dies, no two of which are duplicates and all of which are filled in one shot.

Dies are filled through runners that terminate in restricted gates where the runners join die cavities. As the cavities are filled with molten metal, the air which had filled the cavities is expelled through vents provided for that purpose. Vents are usually thin so that the metal which tends to flow through them will freeze almost instantly and stop the flow, thus building up pressure in the cavity. In some dies, overflow wells are provided at critical points as a precaution against trapping air in the dies and causing porosity in the die castings.

In most modern machines molten metal is forced into the dies by a plunger or ram actuated by air or hydraulic pressure. However, another type of machine used extensively for the die casting of aluminum applies air pressure directly to the surface of the metal. This form of machine is commonly known as an "air gooseneck" machine. While losing out to other types of machines on some of the stronger alloys used for die casting, an exception is noted in the case of large aluminum castings or those requiring one or more gate locations in the die. Pressures of 500 psi are about the economic maximum for gooseneck machines.



Many parts of automatic transmissions are produced as aluminum die castings. One of the complex castings made by Precision Castings Co., Inc. is shown here.

Table I—Selection Factor in Choosing Alloys for Die Castings

		Aluminum Alloys ASTM Nos. S5, SC2	Brass	Magnesium Alloys ASTM Nos. 12 and 13	Zinc Alloys ASTM Nos. 21, 23, 25
Mechanical Properties	Tensile strength	3	1 (Strongest)	3	2
	Impact strength	3	1 (Toughest)	3	2
	Elongation	4	1 (Most ductile)	3	2
	Dimensional stability	2	1 (Most stable)	3	3[a]
	Resistance to cold flow	2	1 (Most resistant)	2	3
	Brinell hardness	3	1 (Hardest)	3	2
Physical Constants	Electrical conductivity	1 (Highest)	2	3	2
	Thermal conductivity	1 (Highest)	2	4	3
	Melting point	2	1 (Highest)	2	3
	Weight, per Cu in.	2	4	1 (Lightest)	3
Casting Characteristics	Ease, speed of casting	2	3	2	1 (Easiest)
	Maximum feasible size	1 (Largest feasible)	2	1 (Largest feasible)	1 (Largest feasible)
	Complexity of shape	1 (Greatest possible)	2	1 (Greatest possible)	1 (Greatest possible)
	Dimensional accuracy	2	3	2	1 (Most accurate)
	Minimum section thickness	2	3	2	1 (Thinnest)
	Surface smoothness	2	3	2	1 (Smoothest)
Cost	Die cost[b]	2	3	2	1 (Lowest)
	Production cost	2	3	2	1 (Lowest)
	Machining cost	2	3	1 (Lowest)	1 (Lowest)
	Finishing cost[c]	3	2	3	1 (Lowest)
	Cost per piece[d]	2	3	2	1 (Lowest)
Extent of Use		2	4	3	1 (Most used)

[a] *Through the use of a low temperature annealing treatment, Alloy No. 23 can be made virtually stable in dimensions.*
[b] *Dies for casting the low melting point alloys are least expensive and have longest life.*
[c] *Includes polishing and buffing expense as well as ease of applying all types of commercial finishes, both electrodeposited and organic.*
[d] *Based on die, material and fuel costs, production speed and machining and finishing costs.*

Zinc alloys and alloys melting at even lower temperatures are cast, as a rule, in machines that have plungers in continuous contact with the molten metal. Because of the relatively low temperatures, neither the plunger nor the cylinder in which it operates are attacked by the molten metals. Machines of this type are fast in operation and provide pressures of between 1000 and 2000 psi, although higher pressures can be attained.

Aluminum, magnesium and copper-base alloys are most frequently cast in "cold chamber" machines. Machines of this type have a cylinder with a port through which molten metal is ladled in measured amounts. Before the metal has had time to freeze, a hydraulic ram is advanced and forces the charge into the die. Pressures usually range between 3000 and 15,000 psi, although pressures up to 25,000 psi and even higher have been used. Cold chamber machines, because of the pressures involved, produce dense castings.

Because most cold chamber machines involve hand ladling of metal they are not as fast as plunger machines. One hundred and twenty die fillings (shots) per hour is generally considered a high rate, although in some favorable cases, 300 and more cycles per hour have been obtained, particularly on the smaller sizes of machines.

Die casting machines, other than those of the cold chamber type, have pots with melting furnaces built in as part of the machine. In some cases, ingots, sprues and rejects are melted in the pot. Some shops do all melting and remelting in separate furnaces and transfer the liquid metal to pots in individual machines.

Some cold chamber die casting machines recently have been equipped with induction furnaces with electromagnetic pumps for automatic supply of molten aluminum into the cold chamber. A refractory tube is inserted into the channels of the furnace and the metal is pumped out by electromagnetic pressure, which is produced by varying the voltage applied to the primary coils. The amount of metal poured can be varied by controlling the duration flow of the current in the primary circuit.

Materials of Which Die Castings Are Made

Die castings can only be made from nonferrous metals, which for the sake of simplicity, are classified into high-melting point and low-melting point groups. The low-melting point group includes alloys of zinc, lead and tin. Zinc is, of course, the most important of these metals as far as die castings are concerned and, prior to World War II, accounted for about 75% of all die castings used.

In the high-melting point group there are the other die casting metals, including aluminum, copper-base alloys and magnesium. Aluminum is the most important in this group, but both magnesium and the copper-base alloys are now being used more extensively. Magnesium is used where less weight is wanted and the copper-base alloys where higher strengths are needed.

Aluminum alloys are slightly inferior to the zinc alloys in mechanical properties, but have other advantages which result in their being chosen for a wide variety of parts. In some fields, particularly in automotive manufacture, zinc and aluminum are frequently used interchangeably for the same parts, the choice being made according to current prices and relative availability.

In physical and mechanical properties the copper-base alloys rank highest, with the alloys most commonly used offering tensile strengths ranging from 45,000 to 90,000 psi. However, these alloys have the highest melting points and are the most difficult to cast. The high temperatures required result in a slow casting rate and cause rapid deterioration of dies.

Table II—Composition and Properties of Zinc Alloys for Die Castings

Designation	ASTM / SAE	XXI / 921	XXIII / 903	XXV / 925
Composition % by Weight*	Copper	2.5 to 3.5	0.10 max.	0.75 to 1.25
	Aluminum	3.5 to 4.5	3.5 to 4.3	3.5 to 4.3
	Magnesium	0.02 to 0.10	0.03 to 0.08	0.03 to 0.08
	Iron, max	0.100	0.100	0.100
	Lead, max	0.007	0.007	0.007
	Cadmium, max	0.005	0.005	0.005
	Tin, max	0.005	0.005	0.005
	Zinc (99.99+% purity)	Remainder	Remainder	Remainder
Mechanical Properties†	Charpy impact strength, ft-lb, ¼ x ¼-in. bar	34	43	48
	Charpy impact strength, ft-lb, ¼ x ¼-in. bar after 10 years indoor aging	4	41	40
	Tensile strength psi	52,100	41,000	47,600
	Tensile strength psi after 10 years indoor aging	48,800	35,000	39,300
	Elongation % in 2 in.	8	10	7
	Elongation % in 2 in. after 10 years indoor aging	4	16	13
	Expansion (growth) in. per in. after 10 years indoor aging	0.0079	0.0005	0.0004
Other Properties and Constants (As Cast)†	Brinell hardness	100	82	91
	Compression strength, psi	93,000	60,000	87,000
	Electrical conductivity—Mhos./cm cube at 20 C	146,000	157,000	153,000
	Melting point—C	379.5	380.9	380.6
	Melting point—F	715.1	717.6	717.1
	Modulus of rupture, psi	116,000	95,000	105,000
	Shearing strength, psi	46,000	31,000	38,000
	Solidification point—C	389.8	386.6	386.6
	Solidification point—F	733.6	727.9	727.0
	Solidification shrinkage—in./ft	0.15	0.14	0.14
	Specific gravity	6.7	6.6	6.7
	Specific heat—cal/gm/C	0.10	0.10	0.10
	Thermal conductivity—cal/sec/sq cm/cm/C at 18 C	0.25	0.27	0.26
	Thermal expansion per C	0.0000277	0.0000274	0.0000274
	Thermal expansion per F	0.0000154	0.0000152	0.0000152
	Transverse deflection—in	0.22	0.27	0.16
	Weight (lb)/cu in	0.24	0.24	0.24

** Composition as provided in ASTM and SAE specifications.*
† Properties and constants are as determined on Zamak alloys by The New Jersey Zinc Co.

Zinc Alloys

Ranking next to the copper alloys in physicals are those based on zinc, considered among the easiest to cast and, in most instances, being lowest in cost per casting. These facts (plus ability to be cast with remarkably smooth surfaces and ease of machining and of plating) account for widest use. Ductility is good and impact strength remarkably high, at normal temperatures, for a cast metal.

It is necessary, however, to employ only high-purity zinc in making the castings because, if the alloys contain more than 0.005% tin or cadmium or more than 0.007% lead, they become subject to sub-surface network corrosion. This necessitates strict adherence to ASTM specifications, a fact well known to all competent die casters and one to be carefully checked by purchasers. Need for care in this respect has resulted in most die casters excluding all lead, tin and cadmium from their plants. Even the use of cadmium-plated or tin-plated steel inserts is not advocated.

Only three types of zinc alloys are now in common use: 1. (ASTM XXI and SAE 921), containing 3% copper, is far less widely used than in years past because it is subject to slight dimensional change and to decrease in impact strength and ductility with aging; 2. (ASTM XXIII, SAE 903), which is copper free; and 3. (ASTM XXV, SAE 925), which has only 1% copper, are not subject to significant dimensional change (only 0.0001 in. per in. in eight years), do not alter significantly in impact strength and actually improve in ductility with aging. For these reasons the second alloy is now most widely used, with the third preferred by most users over the first named.

As shown in Table II, all zinc alloys contain small percentages of magnesium because it aids in making the alloys permanently stable but, if the magnesium content exceeds the limits set, it tends to make the alloys hot short. All zinc alloy specifications call for 4% aluminum content to reduce the tendency of zinc to dissolve

iron, to prevent soldering to the die, and to improve mechanical properties of the alloys. The presence of aluminum prevents sticking of the plunger and of the casting machine in its cylinder and minimizes attack on the iron and steel surfaces with which the molten metal comes in contact. This results in long life of the parts, die life being almost indefinite. In addition, the presence of aluminum helps to hold iron content below the maximum of 0.1% specified.

The low casting temperature (750 to 800 F) of zinc alloys does not result in checking of properly chosen die steel, and it is not necessary to heat treat the dies after machining as for alloys of higher casting temperature, although such heat treatment is sometimes considered expedient for long run dies. Some die casters employ die steel that is heat treated and hardened before machining.

When extreme smoothness of castings is required, especially on surfaces to be plated, the die is highly polished and the castings produced have similar smoothness though they usually have a slightly frosted appearance. This smoothness minimizes polishing and buffing requirements. In many cases, no polishing (except to remove tool marks where flash is sheared off) is needed and only buffing is required to make castings smooth enough for plating. Smoothness, together with ease of applying an enduring plate, is an exceedingly important consideration in the choice of zinc over other alloys and is one factor accounting, in normal times, for a large tonnage in zinc die castings.

Zinc alloys have high fluidity at casting temperatures and do not require injection pressures exceeding 2000 psi, though occasionally cast at higher pressures. Casting is commonly done at pressures of 1000 to 2000 psi, which are adequate to fill any ordinary die and to yield sound castings. This makes it possible to use lighter machines or to make castings of larger size for a given machine than when, as for alloys of higher melting point cast in cold chamber machines, much bigger injection pressures are necessary.

The list of uses to which zinc die castings have been and are being put would reach into the thousands and cover almost any shape of part and all varieties of products ranging from automotive parts to surgical instruments. Included would be cameras, hardware of all kinds, flashlights,

Both large and small parts can be made as die castings. Parts shown here, made by Gries Reproducer Corp., are typical of the latter.

telephones, parking meters, drink mixers, and many, many more.

The zinc alloys are not recommended for use where continuous exposure to steam is anticipated or in dry atmospheres where the temperatures regularly exceed 212 F.

Aluminum Alloys

Aluminum alloys rank second, in extent of use, to the zinc alloys. Costs per casting are quite close, and in some instances, on a basis of volume of metal, metal costs will favor aluminum. This advantage is offset somewhat by higher die costs and a slower casting rate. For certain applications, the lower physical and mechanical properties of aluminum alloys, particularly impact strength, rule in favor of zinc.

In their early history, aluminum alloy die castings were used primarily because of their light weight. Now, however, several other properties of the metal are used to advantage in die castings. For example, the electrical properties of aluminum have been responsible for the use of that metal in die cast electric motor rotors. Its heat transfer properties, light weight and dimensional stability have made aluminum the preferred metal for the die cast portions of automatic transmissions for automobiles.

All standard aluminum alloys are free from intergranular attack, most of them withstand atmospheric corrosion, and others retain a high polish for long periods of time.

Some aluminum alloys are readily anodized, and the anodic coating can be dyed to provide attractive and enduring finishes. Plating is done more extensively than in past years and is definitely a commercial process but is still somewhat more difficult than on zinc, brass or lead die castings. In corrosion resistance, the uncoated aluminum alloys are usually well rated, though white corrosion products do form in time, especially under weathering in moist atmospheres.

Except for iron, tolerances for impurities in aluminum alloys are relatively wide but the molten alloy attacks iron and steel and the pick-up becomes a serious factor if, as in air-injection machines, the surfaces exposed to the molten alloy are large. Die erosion and heat checking occur, especially in long-run work, and necessitate the use of heat resistant heat treated die steels as well as redressing of dies (if smooth surfaces on the castings must be maintained) usually with consequent changes in die dimensions. Solidification shrinkage is also high, tending to accelerate mechanical wear on die parts, especially cores. Soldering of aluminum alloys is difficult, although parts can be brazed. For these reasons, somewhat wider dimensional tolerances are re-

Table III—Composition and Properties of Aluminum Alloys for Die Castings

DESIGNATION										
ASTM	S4	S5	S9	SC2	SC5	SC6	SC7	G2	SG3	SG2
SAE	304	305	—	307	—	306	308	—	—	—
Aluminum Co. of America (Alcoa)	43	13	—	85	—	A380	380	218	360	A360
COMPOSITION %*										
Copper	0.6 max.	0.6 max.	0.6 max.	3.0–4.0	3.0–4.0	3.0–4.0	3.0–4.0	0.2 max.	0.6 max.	0.6 max.
Silicon	4.5–6.0	11.0–13.0	11.0–13.0	4.5–5.5	4.5–5.5	7.5–9.5	7.5–9.5	0.3 max.	9.0–10.0	9.0–10.0
Iron Max	2.0	2.0	1.3	2.0	1.3	1.3	2.0	1.8	2.0	1.3
Magnesium	0.1 max.	0.1 max.	0.1 max.	0.1 max.	0.1 max.	0.1 max.	0.1 max.	7.5–8.5	0.4–0.6	0.4–0.6
Manganese	0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.3 max.	0.3	0.3
Zinc, Max	0.5	0.5	0.5	1.0	1.0	1.0	1.0	0.1	0.5	0.5
Nickel	0.5 max.	0.5 max.	0.5 max.	0.5 max.	0.5 max.	0.5 max.	0.5 max.	0.1 max.	0.5 max.	0.5 max.
Tin, Max	0.1	0.1	0.1	0.3	0.3	0.3	0.3	0.1	0.1	0.1
Total Other Impurities, Max.	0.2	0.2	0.2	0.5	0.5	0.5	0.5	0.2	0.2	0.2
PROPERTIES AND CONSTANTS										
Yd. Str., Tension (Set 0.2%) Psi	14,000	18,000	—	22,000	20,000	23,000	25,000	23,000	23,000	—
Ult. Tens. Str., Psi	30,000	37,000	35,000	38,000	35,000	41,000	43,000	42,000	43,000	43,000
Elong., % in 2 in.	5.0	1.8	3.5	2.5	3.0	3.0	2.0	7.0	3.0	5.0
Charpy Impact, ft.-lb, ¼ x ¼ in. Bar	4.5	2.0	—	2.5	3.0	3.5	3.2	10.0	2.9	4.2
Specific Gravity	2.70	2.66	2.66	2.78	2.78	2.76	2.76	2.53	2.68	—
Weight Lb. per Cu. In.	0.097	0.096	0.096	0.101	0.101	0.099	0.099	0.091	0.097	—
Shearing Str., Psi	21,000	26,000	24,000	26,000	24,000	29,000	30,000	29,000	29,000	—
Melting Point (Liquid temp.) F.	1,165	1,065	1,065	1,145	1,145	1,090	1,090	1,160	1,110	—
Thermal Conductivity CGS Units	0.34	0.37	0.37	0.27	0.28	0.28	0.26	0.24	0.35	—
Thermal Expansion In./In./C.	0.000022	0.000020	0.000020	0.000021	0.000021	0.000020	0.000020	0.000024	0.000021	—
Electrical Resistivity Microhm.-Cm.	4.8	4.4	4.4	6.2	5.9	5.9	6.5	7.1	4.7	—

** Correspond with ASTM specifications in the case of ASTM standard alloys. With minor exceptions, the Aluminum Co. of America is the source for the above data. The composition limits given are from ASTM Specification B85-50T. The mechanical properties are from Alcoa tests or were estimated from available data; the shear strengths, for example, being calculated as about 70% of the tensile strength, which appears to be a good average ratio. The physical properties generally were arrived at by calculations based on an "average" composition and the assumption of reasonably sound castings: in some cases, they were estimated from test results on alloys of similar, but not identical, compositions. Hardness values have not been included not only because of the limited data available, but also because of the inherent variation of this property in any casting.*

quired than for alloys of lower melting point. (See Table VIII.)

There has been an increasing demand for aluminum die castings. Some of this gain has resulted from demand for light weight parts, especially in aircraft and in portable war equipment. The greater demand has also brought an increase in the number of cold chamber die casting machines available, these being considered essential for aluminum die castings of highest quality. These machines may well have a considerable effect upon the future use of aluminum die castings; so, too, will the larger supplies of aluminum alloys.

The 12% silicon-aluminum alloy has long been one of the best aluminum alloys for the die casting of large and intricate parts and parts having thin-walled sections. It possesses excellent casting qualities because of its superior fluidity and freedom from hot-shortness. Other advantages are its excellent corrosion resistance, low thermal expansion, high heat and electrical conductivity, and low specific gravity.

For maximum corrosion resistance, the copper content should be kept below the 0.60% maximum allowed by the specifications. The iron content should be maintained at an optimum of about 1.0% for best results, since ductility is proportionately decreased with an increase in iron content.

The 10 silicon-0.5% magnesium alloy is similar to the 12% silicon alloy in castability and corrosion resistance, but possesses better mechanical properties. Thus, it can readily replace the regular binary 12% silicon alloy when the utmost in strength, ductility and resistance to impact is required.

The 9 silicon-4% copper alloy is a general-purpose secondary alloy that was developed during World War II. It originally was derived from aircraft aluminum scrap, most of which contained about 4% copper. When the magnesium in the scrap was removed and up to 9% silicon was added, the resultant alloy proved extremely suitable for die casting and is now being used in large quantities.

It possesses excellent casting characteristics and good physical properties. Because of its copper content, however, it is somewhat inferior to the copper-free alloys in surface corrosion resistance. While it stands up fairly well under ordinary atmospheric weathering, it must be painted or otherwise protected when exposed to severely corrosive atmospheres.

The 5% silicon-aluminum alloy is used for die castings only because of its relative softness and ductility. It is used primarily for die-cast parts that must be subsequently formed, shaped or worked after casting to facilitate assembly to other parts. It is difficult to die-cast compared to the other standard alloys of aluminum. It has a tendency to "weld" or "solder" to steel die surfaces, although this tendency may be partly overcome by increasing the iron content to 1.50%

or more.

The tensile properties of this alloy are the lowest of all the standard die-casting alloys, and its machinability is poor due to the tendency of tools to drag over its surfaces. Its corrosion resistance is good; but when the maximum in corrosion resistance is required, the percentage of copper, nickel and other impurities must be held to a minimum value.

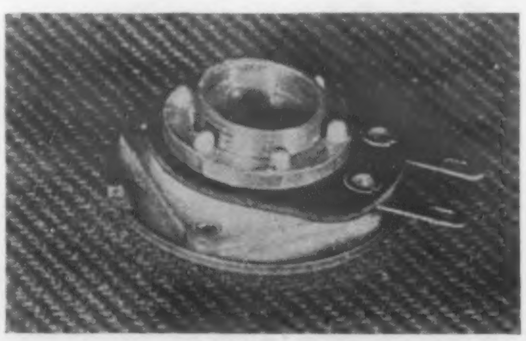
The 8% magnesium-aluminum alloy is essentially a binary magnesium-aluminum alloy. Although somewhat more difficult to die-cast than the other standard alloys, it possesses certain characteristics that merit its use for many applications. It has excellent corrosion resistance and good physical properties—especially a high impact strength. It takes a high, white lustrous polish, has good machinability, and is capable of taking anodizing and coloring treatments better than the other aluminum alloys.

With one exception, all of the aluminum alloys listed in Table III are covered by ASTM specifications. The one known as No. 360 Alcoa is a fairly recent development. This alloy may gain extensive use. The No. 218 Alcoa alloy is also comparatively new, the lightest of those listed, and has good mechanical properties. Impact strength is more than double that for the other aluminum alloys but still is far below that for the zinc alloys. Some consider the No. 218 alloy rather hard to cast, but it has gained in favor partly because (having low silicon content) it anodizes readily without staining when cast under proper conditions.

Aluminum alloys having ASTM numbers S5, SC5 and SC7 (Table III) were once in most extensive use. S5 was often chosen for large or intricate castings, especially those having thin walls, partly because not subject to hot shortness. This alloy ranks high in corrosion resistance but it is somewhat hard to machine, especially when, as in some castings, segregation produces hard spots. Alloy 360 is now preferred by some casters, especially when cast in cold chamber machines. The lower silicon content tends to minimize eutectic segregation and to yield a more nearly uniform structure and less variation in physical properties. Alloy SC2 once provided the best combination of strength and ductility and was commonly employed to obtain these properties, and also where thick sections were included, but both strength and ductility are now better in other alloys, as in SC6, for example. This alloy promises to be available as a low cost secondary metal and has gained widest use as a general-purpose alloy for applications where low cost with near-to-top physicals is wanted. The old ASTM X11 alloy was once among the cheapest general-purpose alloys and attained wide use for small simple castings when air injection machines were still in wide use. Where castings are to be given anodic treatment, the No. 218 alloy is sometimes preferred, although other alloys can be anodized. Those containing more silicon, however, are turned a brownish color that is sometimes streaked.

Silicon imparts good casting qualities to the aluminum alloys and gives them a bluish color. When high silicon content is used, ductility decreases and machining properties are adversely affected. Nickel shortages during war years have discouraged the use of nickel-bearing aluminum alloys, and those formerly listed with 1.75 to 4.5% nickel are no longer in the ASTM specification. Today the ASTM alloys SC6 and G2 and Alcoa alloy 360 cover most aluminum die casting needs and are used exclusively by at least one large die caster when aluminum die castings are called for.

Recent applications of aluminum die castings have taken advantage of the lightness of the alloys plus some of the other favorable characteristics.



The body and adjusting nut of this small microphone are die cast of zinc by Electro-Voice, Inc. Threads are cast in the nut to match those cut in the body of the assembly.

The electrical properties permit the use of die cast aluminum rotors for electric motors; heat transfer properties make certain of the alloys useful in hydraulic transmissions of automobiles, where the dimensional stability is also valuable.

Aluminum alloy die castings are now used extensively in optical equipment and cameras, electric motors, machine parts, sewing and washing machines, cooking utensils, aircraft and automotive parts, and business machines.

Magnesium Alloys

Because essentially the same equipment is used for die casting magnesium as is used in the die casting of aluminum, a large proportion of die casters could produce magnesium die castings without making many changes in processes or equipment. Despite this, the number of plants turning out magnesium die castings is not too great, although the number is increasing constantly. The same cold-chamber machines and die equipment used for aluminum is applicable with the exception that melting furnaces should have a hood so that a nonoxidizing atmosphere can be maintained over the molten alloy. Molten magnesium oxidizes with extreme rapidity when exposed to the air.

In many instances, magnesium alloy die castings are chosen because of their light weight, but they also have other favorable characteristics which include dimensional stability and their nonmagnetic and nonsparking qualities. Per unit of volume, magnesium die casting alloys weigh approximately two-thirds as much as the lightest aluminum die casting alloys, although the difference is not great. Magnesium alloys are the easiest to machine and, in this respect, are much superior to the aluminum alloys and the copper-base alloys which have high silicon contents.

Magnesium alloys have been reputed to have poor resistance to corrosion, particularly against moist atmospheres. However, the reputation is not entirely warranted. The alloys do develop tightly adhering grey oxide coatings, but these do little more than change the surface appearance of the metal. The surface action can easily be retarded by simple chemical treatment after machining. The chemical coating is inexpensive and prepares the die castings for many applications, although special equipment is needed that might not be required for other die casting alloys.

Magnesium alloys have melting points of 1100 to 1120 F as against 1080 to 1195 for aluminum, but their thermal capacity is low. Casting is commonly done at pressures of about 4000 to 15,000 psi. A die temperature of 350 to 600 F is recommended because higher temperatures increase oxide coatings and rougher castings result.

Only two magnesium alloys are commonly die-cast and in both, aluminum is the major alloying element. Each contains small percentages of silicon and has about 0.7% of zinc,

Table IV—Compositions and Properties of Magnesium Alloys for Die Castings

Designation	ASTM	AZ91A
	SAE	501
	Dow Chemical Co.	Dowmetal R
	American Magnesium Corp.	Am 263
Composition, %*	Aluminum	8.3 to 9.7
	Manganese, Min.	0.13
	Zinc	0.4 to 1.0
	Silicon, Max	0.5
	Copper, Max	0.10
	Nickel, Max	0.03
	Magnesium	Remainder
Properties and Constants†	Tensile Strength, Psi	33,000
	Yield Strength, Psi	22,000
	Elongation, % in 2 In.	3
	Brinell Hardness	60
	Izod Impact Strength, Ft-Lb	2
	Specific Gravity	1.181
	Weight per Cu. In.	0.066
	Melting Point, F	1120

* *Composition of alloys as in ASTM Specification.*
† *Properties, as in data furnished by The Dow Chemical Co. and by American Magnesium Corp.*

both elements being used to increase fluidity. ASTM AZ91B alloy combines the better casting properties with higher mechanical properties. The other alloy, AZ91A, is almost identical with AZ91B except that it is somewhat purer. As to specifications, AZ91A has only 0.10% copper as compared to 0.3% in AZ91B. The high purity alloy is seldom used.

Plants that cast both aluminum and magnesium alloys are likely to encounter difficulties from mixing of sprues and gates unless segregation of the respective operations is maintained. Some magnesium die castings have been marketed at the same price per piece as for aluminum, even though melting losses with magnesium are higher and flux is more expensive. Naturally, too, the costs of the base metals greatly affect overall costs, and their relative price position is likely to profoundly affect competitive applications. The plating of magnesium alloys has become commercially practical and several shops are now doing this work. The greatest difficulty lies in getting good surface quality on the casting. The process is not in common use; hence, where light weight plated castings are required, aluminum alloys are likely to be chosen.

Competitive pricing for magnesium alloy die castings depends principally upon metal price, production rates, available secondary metal and shop rates. In general, magnesium becomes more competitive as the part weight increases so that a break-even weight can be established for set values of the variables cited.

Many types of equipment in which portability is important now use considerable quantities of magnesium alloy die castings. Such uses, of course, include such things as typewriters, both portable and stationary, and office equipment. In other types of applications, magnesium has replaced wood, as, for example in many parts of textile machines. Many aircraft instruments utilize magnesium alloy die castings.

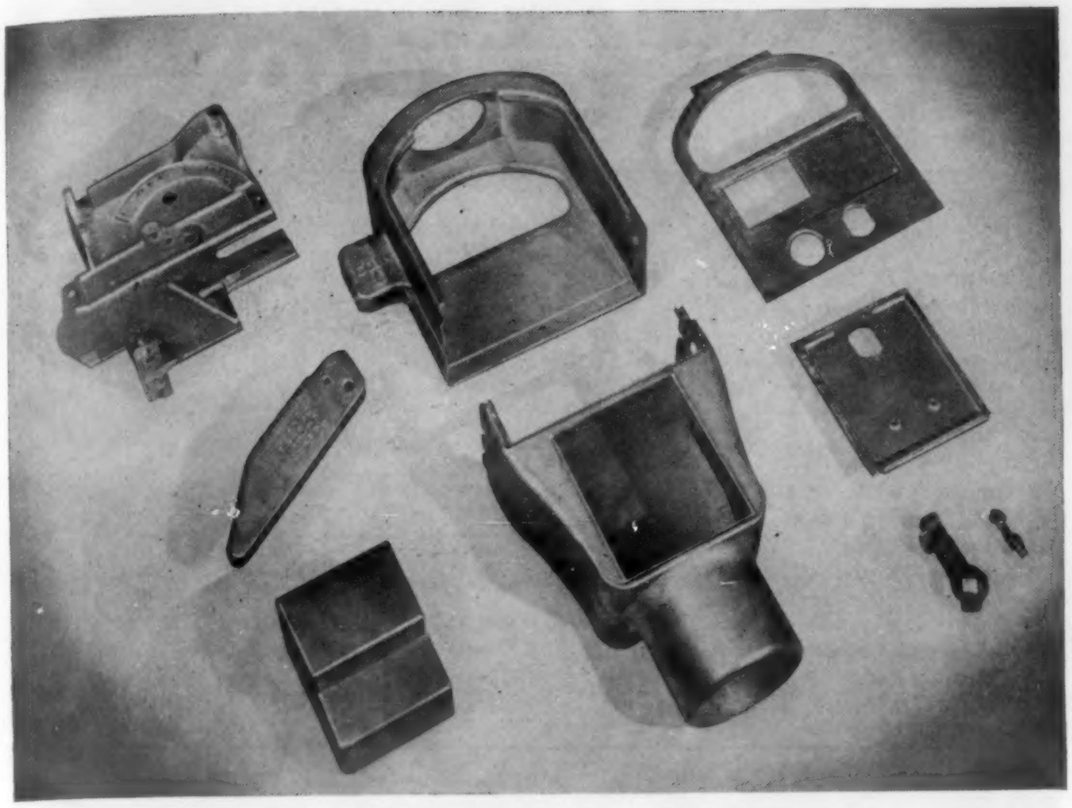
Copper-Base Alloys

Of all the alloys suited to the making of die castings, the copper-base alloys have the highest strengths, but the cost per casting is so high as to prevent the more general use of these alloys. Most frequently cast of the copper-base alloys are the brasses, although several other classes of copper-base alloys have been die cast. The chief difficulty in die casting alloys of this group lies in their high melting points, which extend upward from 1564 F, and because they require from 9000 to 25,000 psi pressure in the dies.

For the most part, the application of die cast brasses has been limited to those parts that are subject to wear in service and where no other type of material can meet requirements. In some cases die castings have been used to replace brass forgings, because the properties do not vary greatly, closer dimensions can be held and more complex shapes as well as thinner sections are practicable.

The three brass alloys most frequently used are designated as Alloys A, B and C. Die casting can be produced in other copper-base alloys, but present practice dictates the use of

Brass and silicon bronze are used in making these die castings, which are representative of those made of copper-base alloys by Pressco Casting & Manufacturing Co.



All of these components of a parking meter are zinc alloy die castings. (Courtesy New Jersey Zinc Co.)

only those alloys that have a melting point under 1650 F. Aluminum bronzes and magnesium bronzes can also be die cast, but the casting temperatures of these alloys are too high to be economical with the die materials presently available.

Alloy A is a general purpose, low cost brass composition that has wide limits as to impurities. Alloy B is a high property alloy having good castability, and good mechanical properties, in the die casting state. Alloy C has better physical properties than Alloy B, and finds considerable use when resistance to wear is an important factor. This alloy sometimes substitutes for mild steel forgings. Other alloys, such as Tinicosil, are sometimes die cast, replacing German silver, but have the disadvantage of high melting point. The lead content in Alloys B and C is low because lead tends to segregate from the base metal, causing gray spots and contributing to hot shortness. Its only advantage is that of improved machinability.

Copper-base alloys are regarded as hardest to cast, and comparatively few die casters are equipped to make them. Minimum dimensional tolerances have to be wider than for other die casting alloys, and die life is shorter as the high temperature of casting results in heat checking. Therefore, mechanical wear, especially on cores, is considerable. Minimum section thickness is above that obtained with other alloys. Copper alloys are highest in density and this, together with rather high cost per pound, tends to make cost of castings high. It is significant, however, that some brass die castings have mechanical properties superior to those of mild steel forgings, and that dimensional stability and corrosion resistance are high; that di-

Table V—Compositions and Properties of Copper Alloys for Die Castings

Common Name of Alloy	Yellow Brass	Doehler Brass No. 1	Doehler Brass No. 4 "Brastil"	Doehler Brass No. 5	Tinicosil
ASTM	Alloy A	Alloy B	Alloy C	—	—
COMPOSITION, %					
Copper	57 min.	63–67	80–83	83.0	42.0
Zinc	30 min.	Remainder	Remainder	Remainder	41.0
Tin	1.5 max	0.25 max	0.25 max	0.25 max	—
Aluminum	0.25 max	0.15 max	0.15 max	1.0	—
Lead	1.50 max	0.25 max	0.15 max	0.25 max	1.0
Manganese	0.25 max	0.15 max	0.15 max	1.0	—
Nickel	—	—	—	—	16.0
Silicon	0.25 max	0.75–1.25	3.75–4.25	5.0	—
Iron	0.25 max	0.15 max	0.15 max	0.25 max	—
Magnesium	—	—	0.01 max	—	—
Other Elements	0.50 max	0.50 max	0.25 max	0.25 max	—
PROPERTIES AND CONSTANTS					
Ultimate Tensile Strength, Psi	65,000	70,000–80,000	95,000	110,000	85,000
Yield Point, Psi	40,000	40,000	55,000	65,000	65,000–72,000
Impact Strength Charpy ft-lb*	33	36	36	30	—
Elongation, % in 2 In.	15.0	25.0	8.0	5.0	15.0
Reduction of Area, %	15–20	—	10–15	—	10–18
Brinell Hardness No.	120–130	120	170	190	160
Specific Gravity	8.5	8.6	8.3	8.2	8.5
Weight per Cu. In.	0.305	0.308	0.297	0.295	0.305
Melting Point, F	1,650	1,575	1,575	1,564	1,675
Solidification Shrinkage, In. per ft.	3/16	—	3/16	—	3/16
Machinability	Fair	Good	Fair	Fair	Good
Corrosion Resistance	Good	Good	High	High	High

* *Not less than these values, which are the highest measurable on the machines used.*

mensions are closer than for steel or brass forgings; and that they accept nickel and chromium plating excellently.

Among the uses to which copper-base alloy die castings have been put are: pump impellers, many types of gears, including those with the teeth cast-in, plumbing fixtures, electric switch parts of complex shape, and bearing retainers of several types.

Lead and Tin Alloys

Lead alloys, though easy to die cast, are soft, low in strength, and higher in cost per casting than zinc alloys. In consequence, applications are limited to those in which maximum density, high corrosion resistance (especially resistance to acids and certain other chemicals) or ready deformability are required. Antimony is commonly added to improve hardness and certain other properties. Creep or cold flow precludes some uses, especially where bending or tension stresses are applied. Pure lead can be die cast, but is too soft for any but exceptional applications (as in certain forms of gaskets, where easy deformability is desired). Fair bearing properties make it possible to die cast inexpensive bearings from lead alloys.

Tin alloys are about on a par with lead alloys in mechanical properties but have better bearing properties and afford high corrosion resistance. Primary uses are those involving direct contact with foods and in small parts in which as-cast dimensions must be within the narrowest possible limits. The alloys were once widely used in die cast bearings but high metal costs make such applications rare, especially with tin scarce.

Table VI—Composition and Properties of Lead Alloys for Die Castings

ASTM Designation	No. 4	No. 5	Bearing Alloy	"C.T." Metal	Tin-Free Alloy
COMPOSITION, %					
Lead	79 to 81	89 to 91	80	85 to 87	90
Tin	4 to 6	—	5	0.65	—
Antimony	14 to 16	9.25 to 10.75	15	12.50	10
Copper, Max	0.50	0.50	—	—	—
Arsenic, Max	0.15	0.15	—	0.65	—
Zinc, Max	0.01	0.01	—	—	—
Aluminum, Max	0.01	0.01	—	—	—
PROPERTIES AND CONSTANTS					
Tensile Strength, Psi	13,800	12,500	9,100	9,800	7,700
Impact Strength, Izod, Ft-Lb	0.6	0.4	0.8	0.2	0.8
Elongation, % in 2 In.	10.5	2.0	3.8	5.5	15.5
Brinell Hardness	23.2	24.1	23.2	18.0	15.5
Specific Gravity	10.24	9.73	10.12	10.38	10.65
Weight, Lb per Cu In.	0.370	0.351	0.365	0.379	0.384
Melting Range, F	459–493	464–514	462–500	473–504	473–498
Solidification Shrinkage In./In.	0.002	—	—	—	—
Corrosion Resistance	Good	Good	Good	Good	Good
Bearing Qualities	Good	Good	Good	Fair	Fair

Table VII—Composition and Properties of Tin Alloys for Die Casting

ASTM Designation	No. 1	No. 2	No. 3
COMPOSITION, %			
Tin	90 to 92	80 to 84	64 to 66
Antimony	4 to 5	12 to 14	14 to 16
Lead	0.35 max	0.35 max	17 to 19
Copper, max	4 to 5	4 to 6	1.5 to 2.5
Iron, max	0.08	0.08	0.08
Arsenic, Max	0.08	0.08	0.15
Zinc, max	0.01	0.01	0.01
Aluminum, max	0.01	0.01	0.01
PROPERTIES AND CONSTANTS			
Tensile Strength, Psi	9,000	10,000	7,800
Elongation, % in 2 In.	2	1	1.25
Brinell Hardness	23–26	30	27.7
Specific Gravity	7.40	7.53	7.98
Weight, Lb per Cu In.	0.266	0.27	0.287
Melting Point, F	400	400	450
Casting Temperature, F	700	760	700
Solidification Shrinkage In./In.	0.002–0.003*	0.002–0.003	—
Corrosion Resistance	High	High	High
Bearing Qualities	Excellent	Excellent	Good

Comparisons of Die Castings and Other Fabricated Forms

Die castings possess, as a class, the following advantages:

1. Rapid production (in lots of many thousands, when required) from a single die with only slight and usually insignificant dimensional changes.
2. Producibility within dimensional limits so close that little or no machining is needed.
3. Smoother surfaces, as cast, than for any other type of casting.
4. Ease of coring close to required size (no sand cores required).
5. Producibility in complex shapes.
6. Permissible section thickness lower than for many other cast parts and as thin as for many stamped parts.
7. Exceedingly low labor cost per casting.
8. Minimum scrap loss.
9. Lower material costs per casting than for most nonferrous castings.
10. Ease of production with inserts of other metals and with some nonmetallic inserts.
11. Freedom from red rust.
12. Comparative ease of plating in several alloys and of applying other finishes.
13. Availability in a wide range of alloys of six base metals.
14. Higher strength than in corresponding sand cast alloys.
15. Producibility with integral fastening elements.

Limitations include:

1. Die cost is considerable (though often lower than for competing processes and generally offset by machining and other economies).
2. Available only in nonferrous alloys and in a narrower range of nonferrous alloys than for sand casting.
3. Not feasible with certain types of cores or in certain shapes than can be sand cast.
4. Is subject to some porosity (although this usually can be held within necessary limits or confined to positions where not significant).
5. Maximum size confined to that feasible in dies can be accommodated in available machines.
6. Require a sizable investment in casting machines and supplementary equipment.
7. Commonly necessitates types of skill so that most die casting is done by specialists.

Limits in respect to maximum weight, minimum wall thickness, minimum variations from drawing dimensions, fineness of threads that can be cast and minimum drafts are given in Table VIII. These data apply to average conditions and are not precisely fixed, that is, the limits may be altered either way when specially favorable or unfavorable conditions apply. When doubt exists, the advice of an experienced die caster should be sought. It is not always possible to predict shrinkage precisely, but when a die has been built and castings made it is usually possible to say with fair assurance how closely given dimensions can be held at least until dies become worn. Naturally, when a measurement on a casting is across the die parting or between die parts that have relative motion, so that varying clearances are involved, limits cannot be held so closely as are those between points that remain fixed.

It is common practice for the caster to maintain dies in good condition but especially when alloys of high melting point are cast, erosion, checking and mechanical wear may be rapid. In particular, when quantities are large, the purchaser should have a definite understanding as to the dimensional limits agreed upon. The same provision should be made on those that, because of die checking, are so rough as to require excessive grinding or polishing to yield surfaces of satisfactory smoothness. On the other hand, when dimensional limits are set closer than common, the purchaser should expect to meet whatever extra costs may be involved in holding these limits. Table VIII gives the minimum variation from drawing dimensions that are commonly set. These are given in inches per inch, as between parts of the die that do not have relative motion.

Die Castings vs. Stampings

As with other manufactured products, die castings are employed only when the balance of advantages over limitations is greater than for products alternatively available. Thus, die castings are frequently selected in favor of other types of castings or in preference to stampings, plastic moldings, screw-machine products or forgings, but there are many cases in which such products hold the balance of advantages and are the logical selection.

These are representative samples of magnesium alloy die castings as produced by Litemetal Dicast, Inc.

As compared with stampings, die castings commonly involve lower die costs, can be made in more complex shapes with fewer assembly operations and within closer dimensional limits. Sections are more easily varied, so as to meet varying stresses, and red rust is not encountered. On the other hand, production rates on stampings may be higher, steel can be used, strength may be better, weight less and sections for equal strength can be thinner. Also, the stamping is free of porosity, may have a smoother surface and be capable of withstanding certain types of abuse that the die casting will not withstand. Many other factors often enter, and each needs to be evaluated by the designer to gain the optimum result.

Die Castings vs. Permanent Mold Castings

As compared with permanent mold castings, the die castings can be made in a wider range of alloys, to closer dimensions, with smoother surfaces and more complex coring, with thinner sections and at a higher rate. Cost per casting is likely to be higher for the permanent mold casting, but the mold may cost less than the die although it is likely to have a shorter life and to involve more upkeep expense. Usually, the die casting is given greater chill and has superior physical properties over one in the same alloy cast in a permanent mold, but the latter is likely to have less porosity. Sand cores can be used in permanent mold work to produce shapes not feasible in die casting, but such cores are not inexpensive and have to be made for each casting produced.

Die Castings vs. Sand Castings

Sand castings have the great disadvantage, as compared with die castings, that a new mold must be made for each casting or gate of castings produced. The same is true of cores, when they are needed. Patterns and match plated are required, too, but commonly cost much less than die casting dies. When casting dies are made, however, they last, as a rule, almost indefinitely and, once their cost is amortized, result in great saving over sand casting, as long as the dies remain in use.

Die castings are much smoother and closer in dimensions than sand castings and usually have most or all holes cored to close limits, whereas

only relatively large holes or recesses are cored in sand castings and then not close to size. These advantages make for far less machining on the die casting. It usually can have thinner sections, is cast at a much higher rate, and usually has better physical properties if the same alloy is used. Sand castings, unlike die castings, are available in ferrous alloys, with some shapes of coring not feasible in die casting and in sizes too large to die cast. Gray iron and many ferrous alloys used in sand castings cost less per pound than nonferrous die casting alloys, and many nonferrous alloys not suited for die casting can be sand cast. Labor costs for sand casting are far higher per casting, as a rule, than for die casting.

Die Castings vs. Forgings

Many parts that are forged can be duplicated as to shape by die casting, but there is little competiton except as between small brass forgings and brass die castings. The latter are likely to be preferred as available in closer dimensions and thinner sections and with cored holes not feasible in forging (unless produced by machining). Forging dies may cost as much as or more than casting dies and have shorter life. Naturally, forged metals, being wrought, have certain advantages over cast metals but, for alloys of the same base metal, physicals may favor either type of part depending on what alloys are compared and in what respects the comparison is made.

Die Castings vs. Screw Machine Parts

Uncounted products of the screw machine can be die cast in the same shape and often at lower cost. Even when comparison is made with steel screw machine products, the die casting may cost less because although cost per pound for the die casting alloy is often higher, there is nearly always a far larger waste in scrap when parts are cut from bar stock than when die cast. In most cases, the die casting will not be so strong or have so smooth a finish (unless machined) as the screw machine product but, for many parts, such differences are not significant and some die castings compete with screw machine products, even though threaded, because the thread is cast.

Many screw machine products require secondary operations, such as milling flats, slotting or cross-drilling but, when equivalent parts are die cast, the flat slot or hole can be formed by the die and no supplementary machining, save flash removal, is required. When the die casting must be machined, cuts are light and chips can be remelted and recast in the same shop, whereas chips from screw machine products commonly have much smaller value.

Die Castings vs. Plastic Moldings

Plastic moldings can nearly always be duplicated in shape by die castings, but the reverse is often not true, as much coring done in die castings cannot be duplicated in molded plastics. Moreover, the die cast part, if of the same section thickness, is stronger, can be held to closer dimensions, is far less brittle (based on impact test figures) and is more stable in dimension. Molds for plastics usually cost more than casting dies.

Plastic moldings do have advantages over die castings in that they are dielectrics, are not subject to corrosion, usually need no applied finish and, in most cases, are lighter in weight for given dimensions. Appearance may or may not be superior in the case of the plastic molding, although it can be transparent or translucent and the die casting is always opaque. Casting rates nearly always exceed molding rates and are far higher when the plastic part is compression molded.

In this, as in other comparisons given above, there are always cases or particular properties in which the die casting is not equal to or better than the competing product. There are many instances, however, in which the die casting has more or greater advantages and fewer and less significant drawbacks and, where this is the case, the die casting is commonly chosen and gives a good account of itself.

Although some die casting alloys, especially those based on aluminum and magnesium, can have physical properties improved by heat treatment, this is rarely done because it is likely to result in the formation of blisters.

Important Design Principles for Die Castings

In many respects, the design principles which govern castings of any type, are applicable to die castings. However, there are some important differences which must be kept in mind to attain the best possible product at the least cost. Therefore, it is highly unlikely that a shift can be made from another cast method to die casting without some design changes or modifications.

Because die costs are the biggest single item of expense in producing die castings, it is important that the part to be produced be designed so as to keep die costs at a minimum. On the other hand, certain advantages might be gained by going to a more expensive type of die. If the added costs of the die will result in appreciable savings in metal, machining or finishing, then they might well be justified. Sometimes it might be advisable to break-down a complex shape into two or more simple die castings and join them into the complete assembly.

Even though the potential user of a die casting has had considerable experience with such parts in the past, it is a good policy to consult a competent die caster before freezing a design. There are many "tricks of trade" which can be used to bring about substantial savings in the cost of die castings. For example, parts which require a bend, arc or twist might best be made as flat castings and then given the final shape through an inexpensive second operation. Die casters who work with such problems every day would be quick to suggest such changes.

The use of coring is an efficient means of saving metal and perhaps eliminating subsequent machining. But, movable cores and die elements are expensive to provide, so a careful analysis must be made. A good rule to follow is to use coring only when absolutely necessary, and, when coring is used, the most economical type is that which remains stationary.

Many of the decisions on the complexity of a part which is to come from the die casting machine might be influenced by the total num-

ber of parts to be produced. Obviously, if the quantity is small it might be cheaper in the long run to use the least expensive die and use more secondary operations to complete the shape. However, if quantities are great the chances are that a bigger die investment might be justified in the savings that could be gained by keeping subsequent operations to a minimum. Once die costs have been written off, economies increase rapidly on reorders of parts, because die casters usually maintain the die without charge.

Here are some specific design suggestions:

Keep over-all dimensions and weight as low as the service requirements of the part will permit.

See that all sections are kept as thin as adequate strength will permit, but not so thin as to create difficulties in casting.

Maintain section thicknesses as nearly uniform as is possible and, where variations are required, see that the transition from one thickness to another is gradual rather than abrupt.

Do not specify small cored holes unless it is certain that they effect a net economy or a result superior to that attainable by drilling or piercing.

Design the die casting so that machine work will be minimized unless machining will provide a means of reducing the over-all cost of the part.

Provide a design that will permit simple and inexpensive flash removal.

Avoid the use of undercuts, such as necessitates slides or complex coring, unless such savings in casting costs which result more than offset the increase in die cost or decrease in casting rate which might result.

Provide ample fillets at inside corners and see that outside edges are slightly rounded, unless there is some strong reason why this cannot be done.

Keep castings as simple in shape as the important requirements of the part permit. This would include the elimination of any nonessential projections.

Avoid large flat surfaces, especially on exposed surfaces of the casting. There is sometimes a tendency for large surfaces to warp.

Never specify tolerances closer than are essential (or closer than on mating parts) unless such tolerances are within the limits common in die casting the alloy from which the parts are to be made.

Where castings are to be machined, allow sufficient metal to make certain that the casting will clean-up when machined, but at the same time will not require deeper cuts than are necessary.

Table VIII—Approximate Dimensional and Weight Limits for Die Castings in Different Alloys

Data apply to average conditions. For exceptional conditions, larger castings, closer dimensional limits and thinner sections may be feasible.

Type of Alloy (Base Metal)	Zinc	Aluminum	Magnesium
Maximum Weight of Casting, Lb	35	20	10
Minimum Wall Thickness, Large Castings, In.	0.050	0.080	0.080
Minimum Wall Thickness, Small Castings, In.	0.015	0.050	0.050
Minimum Variation from Drawing Dimensions per In. of Dia. or Length†	0.001*	0.0015*	0.0015*
Cast Threads, Max. No. per In. External	24	24	16
Cast Threads, Max. No. per In. Internal	24‡	none	none
Minimum Draft on Cores In. per In. of Length or Dia.	0.003	0.010	0.010
Minimum Draft on Side Walls In. per In. of Length	0.005	0.010	0.008

* *Depends on condtions.*
† *Larger variations may be anticipated across die partings or where fits of slides or cores are involved.*
‡ *Where cheaper than tapping.*

Cavity walls and cores must be provided with sufficient draft to permit easy core removal and allow parts to be ejected from the dies without undue pressure on ejector pins.

Make use of integral fastening elements where these will lower assembly costs and still meet other requirements. Depending upon the alloy used, speednuts can sometimes be used directly without any threads being cut on the projection.

When threads are necessary, determine whether they can be cast directly in the part. If cast threads are satisfactory, they will be much more economical than chasing or tapping the threads.

Where castings are to be exposed to view, see that they are pleasing in appearance, conform with mating or adjoining parts that are also exposed, and are so shaped as to be in keeping with the function they perform.

When it is known that the castings are to be polished or buffed, see that the surfaces are so shaped that their entire area can readily be brought into contact with wheels or belts commonly used in this type of finishing.

On parts to be electroplated, recesses should be shallow so that plating will be uniform and complete. Sharp corners and points should be avoided as they are likely to encourage flaking of coated surfaces.

Use cast-in inserts only when they are essential or can be justified in view of the greatly increased cost of casting.

If identifying or decorative letters or numerals are desired, they should be specified as raised rather than recessed figures. Die projections for recessed figures are subject to unusual wear and possible breakage.

Finally, discuss tentative designs of die castings with experienced die casters before finally freezing a design. Frequently, suggestions that these men make can reduce costs and, in many cases, improve the product.

Finishing of Die Castings

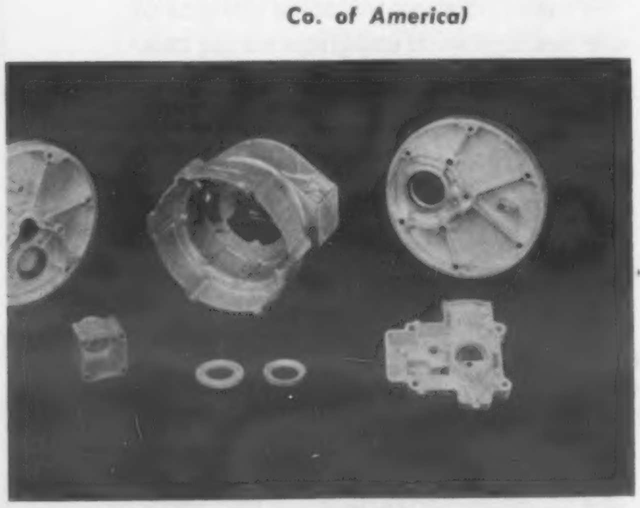
The finishing of die castings is no more difficult than would be the finishing of similar alloys in other forms. Many die castings are used without subsequent finishing other than cleaning or flash removal, but the majority of them are given some finishing operations, depending upon the service conditions under which they must operate. If nothing more, most die castings that are treated are given some type of chemical treat-

ment which acts to prevent unsightly and often destructive corrosion.

Prior to final finishing of die castings, there are likely to be a few machining steps, or at least operations which are designed to remove unnecessary or unwanted metal from the castings. Many of the metal removing tasks are performed by the die caster before the parts are shipped from his shop, but some users prefer to do any final machining themselves.

Most of the die casting alloys present no problem in machining and trimming. Carbide tools are frequently used for long runs of parts as they can be used for long periods of time without the need for re-

Nearly all major lines of industry are represented by aluminum alloy die castings in this group. (Courtesy Aluminum Co. of America)



Savings in cost and weight were achieved in airplane engine starters by using aluminum alloy die castings like these produced by Jack & Heintz Precision Industries.

sharpening. However, high-speed steel and carbon steel tools are used extensively. If good design practice has been followed, only light machining cuts are necessary. These are intended to (1) clean up the surface of the part; (2) provide the final dimensions if these cannot be attained in the die; and (3) provide threads where needed for fastening.

Where no actual machining is required, shaving dies are frequently used for the removal of flash from the parts. Likewise, broaching is a method often employed to remove draft from holes and to attain the final size. In the latter type of work, punches are also used to clean up holes, although this practice is limited to the most ductile alloys. The ductility of some die casting alloys permits the piercing of holes in materials up to 1/8-in. thick. Piercing is often more convenient than coring and probably less expensive on runs of moderate length.

There are a wide variety of finishing processes which can be applied to die castings. In most instances it is necessary to apply the finish immediately after machining or trimming, to avoid the need for any additional cleaning operations which might result from the accumulation of soil, tarnish or oxide coatings. Finishes which can be and are used on die castings include mechanical finishes, electroplating, chemical coatings, organic finishes, dipped metal finishes and plastic coatings.

As with any other type of parts or any other alloy, the quality and appearance of the final finish depends upon the cleanliness and smoothness of the metal upon which the finish is to go. Therefore, the same careful practice that is recommended for any finishing operation is necessary in finishing die castings.

Mechanical Finishes

The mechanical finishing processes, which include buffing, polishing, brushing, tumbling and air or vapor blasting, are most frequently used on aluminum alloys. The methods can be used on other alloys, but there is a tendency on the part of most of them to tarnish in a relatively short time. The oxide coating which forms when aluminum is exposed to the air is transparent and protects the surface underneath. For extreme service conditions, this surface should be given further protection.

Most zinc alloys can be cast with a surface of sufficiently high quality to require only a buffing operation to prepare them for die casting. Parting lines, of course, require a polishing operation. Small parts are suited to barrel tumbling which, depending upon the medium used, provides a polishing or buffing action.

In the case of aluminum alloys, the mechanical finishing processes are frequently used for decorative purposes when no other subsequent finishing is intended. Therefore, the mechanical finishes are more generally used on aluminum alloy die castings than on any other alloy commonly die cast, for the same treatments precede plating and organic finishing. Those aluminum alloys lowest in silicon content attain the best color and brightness, and the magnesium-aluminum binary alloy surpasses all other alloys in this respect.

Polishing and buffing are used on aluminum alloys to attain bright finishes. Less brilliant finishes are achieved through scratch brushing or satin finishing. Sand and vapor blasting are used when matte finishes are desired. Many types of small aluminum die castings are finished by tumbling.

The mechanical finishing of magnesium alloy die castings is necessary because the coating formed by atmospheric action on the alloys is not attractive, although for many uses it is sufficiently protective. As a general rule, therefore, all magnesium alloy die castings are given some subsequent finish. Polishing and buffing, sometimes followed by coloring, are the most frequently applied mechanical finishes on magnesium. These are usually followed by chemical treatments, which can be used alone or as a base for organic coatings.

All of the mechanical treatments are used on the brass die casting alloys which are usually put into service without organic coatings or electroplated surfaces. The surface properties of brass make the addition of other surfaces unnecessary unless a special effect is desired in applications where the high strength of the brass is needed.

Cleaning

After mechanical cleaning, particularly if buffing is employed, die castings, regardless of the alloy used, must be cleaned if any other finishes are to be applied. In most cases, the surfaces of the parts must be both mechanically and chemically cleaned if a satisfactory finish is to be attained. Cleaning is not difficult and follows the general procedures for cleaning metals, with the important exception

that acid baths are required for certain of the alloys.

Polishing and buffing compounds are removed from zinc-base die castings by a combination cleaning method which includes solvent degreasing to remove heavy dirt, an alkaline spray and, finally, an anodic cleaning which removes all traces of dirt and buffing compounds. A rinse and acid dip are then recommended, followed by a final water rinse and thorough drying.

When aluminum alloy die castings are to be plated it is essential that not only dirt and surface impurities be removed but also that the natural oxide coating be removed. Vapor degreasing is the most frequently used cleaning method. Should an alkaline dip be necessary, the solution should contain an inhibitor which keeps the alkaline attack to a minimum. Cleaning is followed by an acid dip which is intended to remove a minute surface layer from the aluminum casting.

Before any kind of a finish can be applied to magnesium alloy die castings, all traces of soil, oxides and impurities must be removed. Usually the parts are cleaned by means of solvents, after which a strong alkaline solution is used. Finally, a chromic acid bath is used to eliminate any traces of foreign matter which might remain.

Electroplating

Electroplating can be applied to most of the alloys which are available as die castings, but this type of finish is used most often on the zinc-base alloys. At the same time, electroplating is the most common finish applied to die castings of these alloys.

Chromium can be plated directly on the zinc alloys, but where outdoor exposure is anticipated, it has been found that it is best to apply an undercoat of copper and nickel beneath the chromium. Pits and surface defects of a like nature will result in poor coatings, so it is necessary that parts to be electroplated be of high surface quality. On some zinc alloys there is a tendency for the copper to diffuse, so best results are obtained with a moderately thick copper coating.

The same copper-nickel base coats are applied when it is desired to plate zinc die castings with brass, silver or gold.

The usefulness of aluminum alloy die castings is being extended to those applications requiring high wear resistance now that a method of electroplating aluminum alloys has been brought to a high degree of perfection. The difficulty in plating aluminum is believed to be caused by the fast forming oxide coating which develops when aluminum is first exposed to air. The most common method of electroplating aluminum is one involving a zinc immersion bath. When a complete zinc coating is attained, plating proceeds as with the zinc alloys. A copper strike is applied, followed by a nickel plated surface, and then the final coating of chromium, silver or brass is applied.

A newer method uses a wet blasting process to clean the aluminum surface of oxides, after which a high-speed chromium plate is applied directly before the oxides have had a chance to form sufficiently to interfere with the plating.

For the past few years there has been available a means of plating on magnesium which also involves the use of a zinc bath to coat the magnesium-base metal. The zinc bath used is completely different than that used for aluminum. As with aluminum, when the zinc coating is applied the die castings can be plated with chromium, silver or gold after the preliminary copper and nickel plates.

Electrochemical Coatings

Certain of the metals that can be used in die castings can be given protective and decorative coatings by electrochemical means. Most of those available are patented processes which involve the use of special chemicals. Methods of this nature are most frequently used on aluminum, although there are some applications on zinc-base alloys.

One of the coatings for zinc produces a lustrous black coating that offers surface protection as well as some decorative value. Another process used on zinc as well as other metals permits a wide range of color combinations. The colors attained depend upon time in the bath, the base metal and the type of surface upon which it is used. When zinc die castings are to be colored in this manner they must first be plated with nickel or copper.

Anodic coatings are widely applied to aluminum alloys. Abrasion and corrosion resistant oxide coatings ranging in thickness from 0.0001 to 0.0005 in. thick are attained by making the part the anode in an electrochemical bath which uses any one of several acids as the electrolyte. Colors can be applied to these coatings through dyeing. The coatings are used for several reasons, but primarily for decorative purposes or for abrasion resistance. In certain instances the coatings are made porous so they will absorb and retain lubricants.

Chemical Finishes

Zinc, aluminum and magnesium die castings can all be given decorative or protective treatments by means of relatively simple chemical baths. Most of the finishes are attained by the use of baths based on chromate solutions. In the case of magnesium, a chemical coating of some kind is used almost universally either for protection by itself or as a base for an organic finish. There are approximately a dozen different baths for magnesium alloys, all of which have been developed for specific purposes.

Two basic types of chemical coatings are extensively used on aluminum die castings. One type produces a jet black finish which is primarily decorative and the other is used basically to promote the adhesion of paints and enamels. Additionally, some aluminum alloys are finished by the use of a caustic etch.

Some of the simpler chemical baths for the die casting alloys are available for anyone's use. However, the majority of processes of this nature are patented. In many cases there are two or three processes of a similar nature which can be used to achieve approximately the same results.

Organic Finishes

Most of the commonly used organic coatings, including paints, lacquers and enamels, can be used on zinc, aluminum and magnesium alloy die castings. To aid in the adhesion of the organic finish, the metal surface must be properly prepared. Preparation includes having a chemically clean surface, which is roughened by sand blasting or prepared with a phosphate or other chemical coating, and finally a primer (usually zinc chromate) should be used.

With innumerable variations of finishes available it would be wise to select a coating with the aid of a paint manufacturer who has been made familiar with all of the conditions which must be met.

Wrinkle and crackle finishes, as well as others that are intended for special effects, are often used on die castings. In the case of the rough finishes, they can be used to hide un-

sightly surface defects, which would be costly to eliminate.

On the alloys with highest melting points, the baked-on finishes are usually recommended because they offer superior abrasion resistance and because they are faster to dry completely.

Where Die Castings Are Used

Die castings are employed today in an exceedingly wide range of products that are manufactured in quantities of 500 or more, or in sufficient quantity to warrant the cost of the dies. This range of casting applications is constantly being broadened as means for lowering cost or improving quality are found and as designers come to appreciate the advantages and the extent of the economies that die castings yield.

Up to the present the automobile industry has been by far the largest user of die castings and has consumed fully half of the total output. Some experts estimate an average of 35 lb of die castings per automobile. Applications in this field include such mechanical parts as carburetor elements, fuel pumps, windshield wipers, horn parts, window regulator components, vacuum and hydraulic brake parts, transmission elements, shock absorber components, lubricant seals, and many others. Even wider use has been attained, however, in parts that perform both a mechanical and decorative function and, as a rule, are plated. These include radiator and radio grilles, hardware, instrument panel components, steering wheel units, lamp bezels and bodies, mirror brackets, hood and fender ornaments, moldings, windshield and window frames, etc.

All but a small fraction of automobile die castings have been in zinc alloy largely because cost per casting has been lowest, strength ample, surfaces remarkably smooth and plating easily done. Recently, large quantities of aluminum alloy die castings have been used in automotive die castings. Here lightness and heat transfer properties are important.

Next in extent of use have been die castings for home appliances and for other electrical applications. These include housings, frames, handles, mechanical parts, gears, agitators, fittings, and the like. Much the largest group of these have been in zinc alloy but, especially where light weight is important, aluminum and magnesium die castings have been chosen. Occasionally castings in lead, brass or tin are found but only where some rather unusual condition has to be met.

In World War II the number of die castings used for shell parts alone exceeded several hundred million. Both zinc and aluminum die castings were used extensively, and millions of lead die castings were made. Many shell castings took the place of screw machine products but others were of shapes not readily made by any machining process. Some had threads cast with high precision. Die castings also were used for small gun mounts, aircraft parts, tank equipment, fire fighting equipment, flame throwers, communication equipment, rockets, cameras, instruments and light machines of many types and other equipment employed by all branches of the service and in corresponding non-service uses. Where ready portability and light weight were essential, the light alloys were specified but not to the complete exclusion of brass or zinc alloys.

In normal times die castings play an important part in such products as vending, business and similar types of light machines, in instruments of great variety, in hardware and tools, in lighting and heating equipment, in such industrial products as pulleys, gears, cams, couplings, pumps, compressors, expansion bolt shields, special nuts, pillow blocks, bearing components, lubricating and painting equipment, fire alarms and extinguishers, escalator units, conveyor elements, hose fittings, wiring devices, fastenings, and scores of other products.

Many optical products, such as binoculars, projectors, cameras, telescopes, lens holders, sighting devices, and the like, have been adapted to quantity production at minimum cost through die cast elements.

In the communication field, telephone components, radio parts, teletype elements, radar parts, special tools, and many related units have been die cast with high economy. In such products, portable units are likely to be in aluminum or magnesium, but zinc alloys are at least equally popular and present some advantages in greater strength, ease of casting and ease of plating.

Die castings have proved popular and successful in plumbing specialties, including full lines of bathroom equipment, shower heads, faucet parts, floor plates, toilet fittings, and the like. Most such products call for zinc alloys that usually are plated but some lead die castings are applied for high corrosion resistance and have replaced some brass fittings because they are not subject to staining corrosion. Now high quantities of brass alloys are used for die cast plumbing equipment.

For toys and novelties, die castings have proved almost ideal, especially where fine details (as on model locomotive, airplane, car, truck, bus and similar items) are necessary. The volume of such items is large in peacetime, as the parts are low in cost, are easily reproduced, and are realistic replicas of larger products.

With such diversity (and uncounted products that might be named have not been mentioned) die castings enter into an extraordinary range of products and have become indispensable. Die casting often displaces parts made in economical forms by other processes (and usually with lower cost) but is not often displaced by competing products. It is thus a virtual certainty that die casting will continue to grow in popularity and in extent of use. This trend is all the more certain when one considers the growing pressures towards producing more exact shapes requiring a minimum of machining.

Acknowledgments

The author wishes to make the following acknowledgments in connection with the preparation of this manual. First credit is due Herbert Chase, who prepared the original Die Casting manual in this series, which appeared in the November 1945 issue of MATERIALS & METHODS, and whose work served as the framework around which the present manual was built. Others to whom we offer special credit are: C. R. Maxon, The New Jersey Zinc Co.; R. C. Cornell, Litemetal Dicast, Inc.; E. A. Butner, Hydropress, Inc.; F. C. Bennett, Dow Chemical Co.; and E. F. Brissie, Doehler-Jarvis Corp. In addition, our thanks are due Aluminum Co. of America, Precision Castings Co., Inc., and Kux Machine Co.

Materials & Methods

Materials Engineering File Facts

NUMBER 212
August, 1951

Materials Data Sheet

Low Carbon Steels

These are the most widely used steels, including the common structural steel analyses (0.15–0.25% C). They can be furnished rimmed or killed. The low carbon steels are tough but comparatively weak, although their strength, hardness and machinability can be improved by cold work. Heat treatments other than carburizing or salt bath hardening are not recommended, except for special grain refining. The general rules within this range are that increasing the manganese content improves the machinability and hardening characteristics, while increasing the carbon brings better response to heat treatment, higher yield and tensile strengths, and better machining and forging qualities. The higher the carbon content, the lower the drawability, however.

AISI Type	C1010	C1015	C1018	C1020	C1025
COMPOSITION, %	C, 0.08–0.13 Mn, 0.30–0.50 P (max), 0.040 S (max), 0.050	C, 0.13–0.18 Mn, 0.30–0.60 P (max), 0.040 S (max), 0.050	C, 0.15–0.20 Mn, 0.60–0.90 P (max), 0.040 S (max), 0.050	C, 0.18–0.23 Mn, 0.30–0.60 P (max), 0.040 S (max), 0.050	C, 0.22–0.28 Mn, 0.30–0.60 P (max), 0.040 S (max), 0.050
PHYSICAL PROPERTIES					
Density, Lb/Cu In.	0.283	0.283	0.283	0.283	0.283
Melting Point Range F	2750–2775	2750–2775	2750–2775	2750–2775	2750–2775
Thermal Cond, Btu/Hr/Sq Ft/Ft/F, @ 212 F	27	27	27	27	27
Coeff of Exp per F: 70-1200 F	8.4×10^{-6}	8.4×10^{-6}	8.4×10^{-6}	8.4×10^{-6}	8.4×10^{-6}
Spec Ht, Btu/Lb/F:	0.10–0.11	0.10–0.11	0.10–0.11	0.10–0.11	0.10–0.11
Elect Res, Microhm-Cm @ 68 F:	14.3	14.3	14.3	14.3	14.3
Magnetic Properties	Magnetic	Magnetic	Magnetic	Magnetic	Magnetic
MECHANICAL PROPERTIES					
Mod of Elast in Tension, Psi	$29\text{-}30 \times 10^{-6}$	$29\text{-}30 \times 10^{-6}$	$29\text{-}30 \times 10^{-6}$	$29\text{-}30 \times 10^{-6}$	$29\text{-}30 \times 10^{-6}$
Tensile Str, 1000 Psi:					
Hot Rolled	51	61	69	65	70
Cold Worked	56	74	82	78	80
Yield Str, 1000 Psi:					
Hot Rolled	29	46	48	43	45
Cold Worked	33	62	70	66	69
Elong in 2 In., %:					
Hot Rolled	38	39	38	36	31
Cold Worked	35	24	20	20	18
Reduction of Area, %:					
Hot Rolled	70	61	62	59	58
Cold Worked	65	57	57	55	48
Hardness, Bhn:					
Hot Rolled	101	126	143	143	143
Cold Worked	113	143	163	156	162
Impact Strength	The impact strengths of these steels are markedly dependent on the details of the processing, such as deoxidation practice, rolling practice, section size, etc. Impact strength is affected a great deal more by these variables than the other mechanical properties.				
Fatigue Strength	Fatigue properties are dependent on the thermal and mechanical history of the piece, although not to the extent that impact strengths are. A range of 40–50% of the tensile strengths is a conservative estimate of the fatigue strengths of these steels.				
THERMAL TREATMENT					
Annealing Temp, F	1650–1750	1650–1750	1650–1750	1650–1750	1600–1700
Hardening Temp, F	1650–1700[1]	1650–1700[1]	1650–1700[1]	1600–1675[2]	1600–1675[2]
Tempering Temp, F	300–1350	300–1350	300–1350	300–1350	300–1350
FABRICATING PROPERTIES					
Machinability Index (Free-Cutting 1112 steel)					
Hot Rolled	40	50	52	50	52
Cold Worked	45	58	65	60	65
Weldability	These steels are easily welded by all the commercial welding procedures—including gas, arc, bronze, thermite, oxyacetylene and submerged-melt welding—and the resulting welds are of extremely high quality.				
CORROSION RESISTANCE	These steels are rusted by oxygen and water, the rate of attack increasing sharply as the pH goes above 4 and decreasing below a pH of 8, at room temperature. Dilute salt solutions increase the corrosion rate. The carbon steels are attacked by acids, in general, but are satisfactorily resistant to alkalies at normal temperatures. The corrosion rate in ordinary rusting is not appreciably affected by the carbon or alloy content or by cold working within this carbon range.				
AVAILABLE FORMS	These steels can be obtained in all mill forms. Structural mild steel, in which the common shapes are supplied unless otherwise specified, falls somewhere in these ranges of compositions.				
USES	These steels can be carburized to give a hard surface on a part which retains its tough inner core. A few representative machine applications apart from structural shapes are automobile spiders, gears, clutch disks, bolts, bearing races, cam shafts, crank shafts, piston pins, cams, pneumatic tool cylinders, gun blocks, bushings, stud and collar bolts, shifter shoes, draw bars, pivot pins, cap screws, precision shafting, scythe blade heels, flanges, shackles, tie rods, drag links, steering gear connecting rods, thrust washers and wrenches.				

NOTES: [1] *Water quench, brine or caustic frequently used.*
[2] *Soluble oil solution used for hardening bolts; mineral oil used when quenching for machinability.*

"B&W Allmul Firebrick keeps saving money for me!"

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- Welding furnace
- Non-ferrous reverberatory furnace
- Butt-weld furnace
- Slag melting furnace
- Dutch oven—French oxide furnace (zinc)
- High BTU gas generator
- Oil fired periodic ceramic kiln
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- Lead melting furnace
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Even under very severe service conditions, B&W Allmul Firebrick wins repeat orders! That's because this remarkable, electrically-fused mullite firebrick is low in cost . . . due to a special mass production process developed by B&W engineers.

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Materials & Methods

Materials Engineering File Facts

NUMBER 213
August, 1951

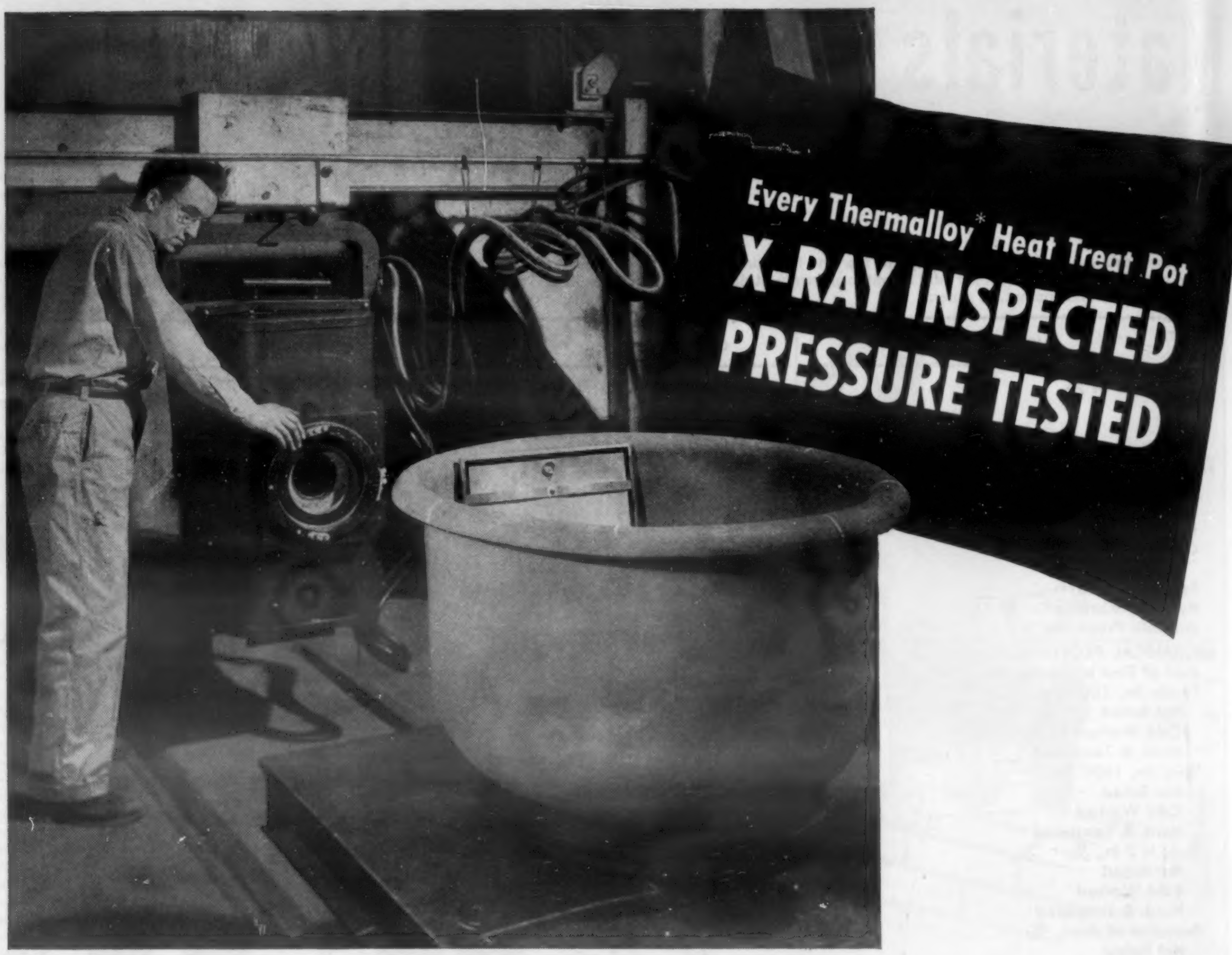
Materials Data Sheet

Medium Carbon Steels

These steels are intermediate between the low and high carbon steels. They are not generally carburized, although the higher carbon members respond well to heat treatment, with proper care in water-quenching thin sections. Analyses in this range are used for plain carbon forgings, the larger the forging, the higher the carbon content, in general.

AISI TYPE	C1030	C1035	C1040	C1045
COMPOSITION, %	C, 0.28–0.34 Mn, 0.60–0.90 P (max), 0.040 S (max), 0.050	C, 0.32–0.38 Mn, 0.60–0.90 P (max), 0.040 S (max), 0.050	C, 0.37–0.44 Mn, 0.60–0.90 P (max), 0.040 S (max), 0.050	C, 0.43–0.50 Mn, 0.60–0.90 P (max), 0.040 S (max), 0.050
PHYSICAL PROPERTIES				
Density, Lb/Cu In.	0.283	0.283	0.283	0.283
Melting Point Range, F	2700–2750	2700–2750	2700–2750	2700–2750
Thermal Cond, Btu/Hr/Sq Ft/Ft/F, @ 212 F	27	27	27	27
Coeff of Exp per F: 70-1200	8.3×10^{-6}	8.3×10^{-6}	8.3×10^{-6}	8.3×10^{-6}
Spec Ht, Btu/Lb/F:	0.10–0.11	0.10–0.11	0.10–0.11	0.10–0.11
Elect Res, Microhm-Cm @ 68 F:	19	19	19	19
Magnetic Properties	Magnetic	Magnetic	Magnetic	Magnetic
MECHANICAL PROPERTIES				
Mod of Elast in Tension, Psi	$29\text{–}30 \times 10^{-6}$	$29\text{–}30 \times 10^{-6}$	$29\text{–}30 \times 10^{-6}$	$29\text{–}30 \times 10^{-6}$
Tensile Str, 1000 Psi:				
Hot Rolled	80	85	91	98
Cold Worked	85	92	100	103
Hard. & Tempered	98[1]	103[2]	113[2]	120[3]
Yield Str, 1000 Psi:				
Hot Rolled	50	54	58	59
Cold Worked	72	79	88	90
Hard. & Tempered	70[1]	72[1]	86[2]	90[2]
Elong in 2 In., %:				
Hot Rolled	30	30	27	24
Cold Worked	26	25	17	14
Hard. & Tempered	27[1]	23[2]	23[2]	18[2]
Reduction of Area, %:				
Hot Rolled	56	53	50	45
Cold Worked	51	50	42	40
Hard. & Tempered	64[1]	59[2]	62[2]	52[3]
Hardness, Bhn:				
Hot Rolled	163	183	201	212
Cold Worked	179	201	207	217
Hard. & Tempered	212[1]	230[2]	235[2]	277[3]
Impact Strength	The impact strengths of these steels are markedly dependent on the details of the processing, such as deoxidation practice, rolling practice, section size, etc. Impact strength is affected a great deal more by these variables than the other mechanical properties.			
Fatigue Strength	Fatigue properties are dependent on the thermal and mechanical history of the piece, although not to the extent that impact strengths are. A range of 40–50% of the tensile strengths is a conservative estimate of the fatigue strengths of these steels.			
THERMAL TREATMENT				
Annealing Temp, F	1550–1700	1500–1650	1450–1600	1450–1600
Hardening Temp, F	1575–1650[4]	1525–1600[4]	1500–1575[4]	1475–1550[4]
Tempering Temp, F	300–1350	300–1350	300–1350	300–1350
FABRICATING PROPERTIES				
Machinability Index (Free-Cutting 1112 steel):				
Hot Rolled	60	60	60	55
Cold Worked	67	67	65	60
Hard. & Tempered	55	55	55	50
Weldability:	These steels are easily welded by all the commercial welding procedures—including gas, arc, bronze, thermite, oxyacetylene and submerged-melt welding—and the resulting welds are of high quality. Preheat and postheat treatments are frequently necessary.			
CORROSION RESISTANCE	These steels are rusted by oxygen and water, the rate of attack increasing sharply as the pH goes above 4 and decreasing below a pH of 8, at room temperature. Dilute salt solutions increase the corrosion rate. The carbon steels are attacked by acids, in general, but are satisfactorily resistant to alkalies at normal temperatures. The corrosion rate in ordinary rusting is not appreciably affected by the carbon or alloy content or by cold working, within this carbon range.			
AVAILABLE FORMS	These steels can be furnished in all the standard mill forms.			
USES	Typical applications include shafts, brake shoe parts, gears, tie rods, brake and clutch pedals, truck rim side rings, sucker rods, connecting rods, shifter levers, pitman arms, flywheel rings, I beam axles, crankshafts, cam shafts, wheel hubs, pins, tools, plowshares, sway bars, mine bits, lock washers, bumper bars, springs, road scraper blades, scarifier teeth, grinding balls, grader blades, knife blades, harrow disks, hay rake teeth and leaf springs.			

NOTES: [1] *One-inch Rd water quenched 1575 F, drawn 1000 F.*
[2] *One-inch Rd water quenched 1525 F, drawn at 1000 F.*
[3] *One-inch Rd water quenched 1550 F, drawn at 1000 F.*
[4] *Oil and water quenching mediums used. Brine or caustic are frequently employed in water.*



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HERE'S PROOF OF QUALITY!

• Life of Electro-Alloys neutral salt pot proved to be eight times that of competitive type pot formerly used. User saved over $100 on initial cost alone during life of one pot—plus replacement labor costs of seven pot changes.

• With a competitive alloy, customer was receiving 1,500 to 3,500 hours service. On switching to Thermalloy pots, service life jumped to 3,800-5,550 hours in identical service.

To insure the soundness necessary for low-cost service, every Thermalloy Heat Treat Pot is subjected to thorough internal and external inspection. Two X-ray machines, operated by trained radiographers, reveal any hidden flaws or weaknesses which might shorten service life. Pots are also pressure-tested at 60 pounds per square inch. This eliminates the possibility of porosity that does not show up on X-rays.

This careful inspection, plus Thermalloy's outstanding heat-resistant properties, are your guarantee of top quality. Why not make Thermalloy your standard in buying heat treat pots?

Over 100 sizes in both round and rectangular pots are available for production from stock patterns. Write for Bulletin T-205, listing shapes and sizes available. Electro-Alloys Division, 2088 Taylor St., Elyria, Ohio.

Specify THERMALLOY* for heat and abrasion resistance... CHEMALLOY* for corrosion resistance

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AMERICAN **Brake Shoe** COMPANY

ELECTRO-ALLOYS DIVISION

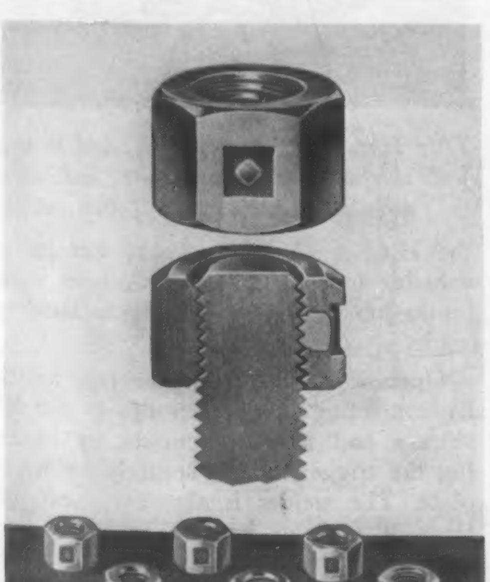
ELYRIA, OHIO

New Materials and Equipment

Newly Designed Fasteners Announced

Two new designs in gang channel and anchor nuts, introduced by the *Elastic Stop Nut Corp. of America,* 2330 Vauxhall Rd., Union, N. J., are expected to effect a savings in weight ranging from 25 to 30% with no sacrifice in strength. These new parts are manufactured in conformance with Specification AN-366, and are approved for use by aircraft manufacturers. They are said to be available for applications where heavier types of nuts have been used, and both are directly interchangeable with other AN parts, since they are designed within the same overall envelope dimensions.

A new type of retainer, designed to act as an economical self-locking nut on threaded shafts, has been announced by *Waldes Kohinoor, Inc.,* 47-16 Austel Pl., Long Island City, N. Y. The triangular shaped nut has a drawn helical segment with a tapered inner edge that forms a single thread conforming with American Standards. When screwed on a threaded shaft, the dished triangular body flattens under torque and secures an equal load distribution against the part being held. Separate washers are unnecessary.



In this cross-section view of the Townsend Nylok Type E Locknut, the mating threads are shown wedged together at the left, while the gripping action of the nylon plug is demonstrated at the right.

Another type of self-locking nut offered by the *Townsend Co.,* New Brighton, Pa., uses extruded nylon as the locking medium. The design of the nut is said to permit installation from either end and to provide positive locking action in any position. Installation torque is low, which saves time, and lock washers, subsequent double assembly, and handling and stocking problems are eliminated.

Aluminum Co. of America, Pittsburgh 19, is currently offering on an experimental basis a new aluminum alloy rivet in the large size range which is said to be stronger than any previously developed. The new rivet alloy has been temporarily designated as XB77S, and rivets of this material can be hot driven by hand pneumatic hammers. In developing the new alloy, Alcoa has been successful in providing the following characteristics: an average shear strength of 38,000 psi within two weeks after driving, a wide temperature range (850 to 975 F), and good resistance to corrosion when used in recommended applications. The best results for the final driven rivet are predicted on the normal paint protection afforded various aluminum structural applications.

Clad Steel for Brazing Reduces Cleaning, Fluxing Operations

To simplify the brazing of steel joints and at the same time guarantee their perfection, the *American Silver Co., Inc.,* 36-07 Prince St., Flushing, N. Y., has introduced a braze-clad low carbon steel strip.

The steel strip is clad with silver brazing alloy on one or both sides, in any thickness ratio and melting range desired. The surface is precoated evenly with the brazing alloy, requires no preplacements, and every joint is assured of a complete and uniform spread of alloy. In conventional brazing practice, where preplacements of silver alloy strip are used, voids leading to joint failures are known to occur frequently. This is due to the fact that the brazing alloy, when melted, initially draws up into a liquid ball and then spreads unevenly over the joint surface, resulting in the formation of oxide islands and gas pockets, as well as the presence of flux inclusions.

This Braze-Clad steel is available in all thicknesses down to 0.005 in. and in any width up to 4 in.

Braze-Clad joint surfaces, being prediffused with the alloy, are said to eliminate the need of such preplacements as wire rings, sheet washers and blanks, and thus reduce considerably the tedious cleaning and fluxing operations before brazing. Pre-diffusion is also claimed to control the flow of the metal during brazing and to eliminate the necessity of cleaning of any overflow or unwanted fillets. The heating cycle is also reduced since there is no need to depend upon the unpredictable capillary flow to distribute the brazing alloy.

Alkyd Molding Compound Has Improved Electrical Properties

A third type of alkyd molding compound has been announced by the Plaskon Div., *Libbey-Owens-Ford Glass Co.,* Toledo. Designated Plaskon Alkyd 422, the new material is said to be a flame-resistant

New Materials and Equipment
(CONTINUED)

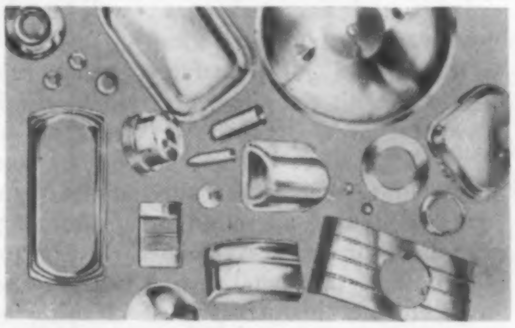
compound with improved electrical properties.

Comparable in most other respects to the present compounds of this type (Plaskon Alkyds 411 and 420), the new compound is listed as self-extinguishing under ASTM and Underwriter Laboratories flame resistance tests. It is also claimed to retain its electrical properties on exposure to high humidities and temperatures, and, as further evidence of its general moisture resistance, quickly regains its electrical properties after periods of immersion.

Other properties of the new compound are: possesses the same fast rates of cure (molds about four times as fast as standard thermosetting plastics); and possesses the same high arc resistance and dimensional stability as the other members of the alkyd family of molding materials.

Specially Processed Brass Is Stronger, Harder

The *American Brass Co.,* Waterbury 20, Conn., has announced the development of Formbrite copper alloy sheet, strip, wire, rod and tube. An unusual combination of physical and fabricating qualities are claimed for the process, the manufacture of which involves a special procedure



These parts have all been fabricated from Formbrite, a specially processed brass alloy said to have unusual physical and fabricating qualities.

of rolling or drawing and annealing brass containing 63 to 90% copper to obtain exceptionally fine grain-size (about 0.008 mm).

Physically, the metal is said to be stronger, harder and springier than ordinary drawing brass, but yet retains remarkable ductility for deep drawing, forming and cold upsetting. Its harder surface tends to resist abrasion and scratching.

Sheet and strip manufactured by this method is offered for practically all drawing brass purposes. Because of its initial high strength and stiffness, cold fabricated parts acquire added strength and stiffness and frequently can be made of thinner metal than if the usual deep drawing brass were used.

Another advantage claimed for the new metal is that its grain structure provides so smooth a surface that a simple buffing operation produces a lusterous finish, thereby effecting substantial savings in finishing costs.

Costing no more than ordinary drawing brass, Formbrite can be supplied equivalent to ASTM Specifications for either quarter or half-hard stock.

Metal-Chemical Combination Resists Corrosion

A new alloy of metals and chemicals produced by bringing together an alloy of molten metal plus an alloying of a wet chemical mass has been developed by *Chemalloy Associates,* Santee, Calif.

Said to defy rust, resist corrosion, work without lubricants in moving machines or parts, remain cool while being lathe-turned, and to be made at a reasonable cost from either scrap or virgin materials, the new metal can be melted or remelted like ordinary metals after it is made.

Basically made from Chemalloy zinc, the metal is said to have far more properties and possibilities than zinc metal.

According to the manufacturer, applications include:

1. Dry bearings
2. Free machining metal
3. Pressure die casting
4. Welding rod without the use of flux
5. Heat dissipation

New Bi-Metal Permits Saving of Critical Materials

A new bi-metal developed in the Allied zone of Germany which consists of aluminum with a layer of copper welded to it by an exclusive process, and rolled to specific thicknesses, is currently offered by *Eastern Brass & Copper Co., Inc.,* 1126 E. 180th St., New York, who holds exclusive processing and distribution rights for the Americas.

According to the company, Cupal's possibilities for hard goods, where it can be a substitute for aluminum and copper, are unlimited. Commercially, aluminum cannot be electroplated or soldered—the new bi-metal, however, can be electroplated or soldered on the copper clad side, making it extremely useful for fabricated parts which require plating on one side only.

The development of Cupal opens new fields for aluminum by exploiting all of its industrial advantages combined with the additional properties of copper. Chemically practical for the first time, one-sided plating will mean a 50% saving in silver, chromium and other plating materials.

Applications have been found for Cupal in the aircraft, electrical and electronics fields.

Portable Spot Welder

A precision-built portable resistance spot welder suitable for on-the-job repair of inconel and stainless steel foil and screen, and for making alterations required by changes in design, is currently available from the *H. I. Thompson Co.,* 1733 Cordova St., Los Angeles 7.

Originally developed for the repair and alteration of Refrasil insulating blankets,

This portable spot welder is said to weld foil thicknesses up to 0.004 and screen wire diameters up to 0.020 in.

the Hit-Kit (No. 45-21144) has proved valuable in many other applications where on-the-job repairs or changes must be made.

Operation is by a trigger type switch. By contacting both electrodes to the foil surface and inducing current by operating the trigger, foil is securely welded in place. The welder is also equipped with leads 9 ft long which are attached to welding tips and which operate on 110 a.c. Power consumption is low, assuring economical operation.

Diamond Abrasive Compound

Availability of a new diamond abrasive compound designed for sizing and polishing carbide wire drawing and heading dies has been announced by the Industrial

"KARBATE" BRAND HEAT EXCHANGERS IMPERVIOUS GRAPHITE *FOR ALL PURPOSES!*

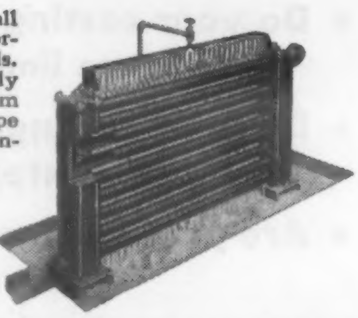
The "Karbate" impervious graphite heat exchangers illustrated are used extensively as boilers, coolers, condensers, vaporizers, evaporators, heaters and absorbers in handling corrosive chemicals, either hot or cold. They *all* can be had in a complete size range. *All of them* offer the following advantages:

- **Highest heat conductivity rate of the practical corrosion-resistant materials.**
- **Highly resistant to corrosion by acids or alkalis, hot or cold.**
- **Freedom from corrosion scale, as compared to metals.**
- **Immune to thermal shock.**
- **No contamination of product.**
- **Strong and easy to install and maintain.**

Shell-and-Tube: Series 70A—Two sizes, 16.4 sq. ft., and 24.6 sq. ft. of outside surface area respectively. Tubes easily replaced in the field. Interchangeable single and double-pass construction.

Style FH heat exchangers (Size 1½): Are especially recommended for tanks with solution depths of 16 inches or less. Write for catalog section S-6750.

Series 240A—70.6 feet of outside heat transfer surface. Easy tube replacement. Easily converted on job to single, double, or four-pass tube side flow by simple change of fixed covers. Steel, shell, oversize shell connections, impingement plates and drain and vent plugs integral with shell end castings. Stainless-steel baffles assembled with steel tie rods to form protective cage for tube bundle. Removable "Karbate" tube bundle. Write for catalog sections for S-6690, S-6715 for details of applications, maintenance, sizes and characteristics of these exchangers.



Cascade coolers: For all cooling jobs involving corrosive gases and liquids. Complete cooler assembly may be made quickly from 4 standard items in 5 pipe sizes. Capacity easily enlarged or reduced by adding or subtracting standard sections. Compact construction to save plant room. No special supporting structure needed. Write for catalog section S-6780.

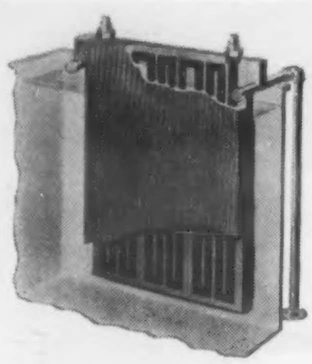
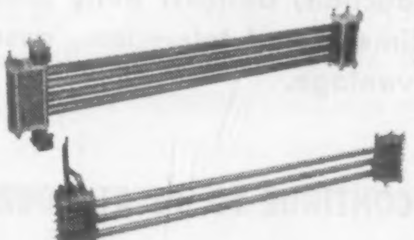


Plate heaters: Used to heat or cool corrosive liquids in tanks and vessels. Compact, completely assembled, easy to put in. Used in pickling, etching, plating and cleaning tanks. Complete size range. Models for horizontal and vertical mounting. Write for catalog section S-6620.



Concentric Tube exchangers: Available in two types. Series 10A is small, low-priced, gives true counterflow. Exceptionally good for small flow rates at narrow temperature differences . . . Series 20A manufactured with "Karbate" inner and outer piping, and is used to transfer heat between two corrosive fluids. Both have sectional construction, can be added to or subtracted from at will. Sturdy, can be moved from place to place after assembly, adapted to any method of mounting on floor, wall, or ceiling. Write for catalog section S-6670.

The term "Karbate" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

In Canada: National Carbon Limited
Montreal, Toronto, Winnipeg

A full line of "Karbate" impervious graphite pipe and fittings

for conveying corrosive chemicals includes: "Karbate" pumps of advanced design embodying impervious graphite case, impeller, and a rotary seal which eliminates the stuffing box. Pump prices reduced up to 33%. Write for catalog section S-7000 for pipe information, S-7200 for pump information.

New Materials and Equipment

Products Div., *Elgin National Watch Co.*, Elgin, Ill.

Specific advantages claimed for the compound are:

1. 20% faster than diamond-olive oil mixtures when applied to carbide.
2. Proper viscosity for convenient application.
3. Resistant to slinging and has an inherent property of working down the lapping stick or pin to the actual work area.

In addition to these advantages, new Dymo-C is said to embody all of the features of standard Elgin Dymo diamond compound — convenience of application (no mixing required), resistance to drying out, deterioration or settling, and uniformly precise grinding of diamond particles.

New Wet-Blaster Reduces Maintenance

A new metal-working procedure in the fields of high speed, accurate deburring, descaling, stock removal and general surface finishing is now available for wide industrial application through the use of the Cro-Hone Pressure-Blast offered by the *Cro-Plate Co., Inc.*, Hartford 5.

A self-contained, low-cost, easily installed unit, the wet-blaster is said to reduce maintenance and down time by eliminating all moving parts.

In operation, the work to be finished is

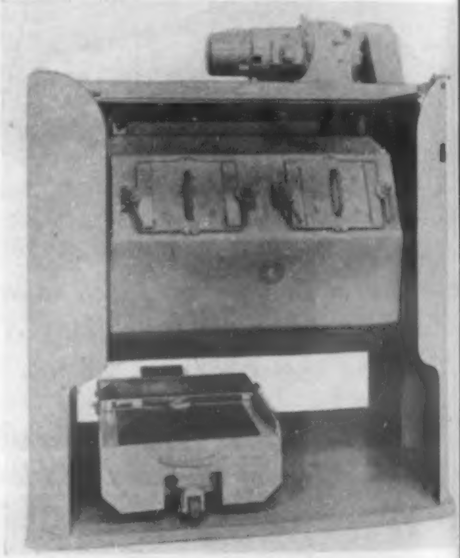
This wet-blaster increases the speed of the abrasive slurry as it is forced against the work. Conventional speeds are said to be trebled.

New Materials and Equipment

inserted in the 30 by 30-in. cabinet through the front hand-holes or side doors. Both entrances are fitted with splash-proof guards which allow neat, leakage-free installation. Mechanical knee actuating valves and controls are located within easy reach at the front of the cabinet, and a large, clear-view window enables the operator to watch the progress of the work.

Tumbling Finishing Machines

Crown Rheostat & Supply Co., 3465 N. Kimball Ave., Chicago 18, has announced new improvements in their line of tumble finishing machines which are used in aircraft, armaments and other



This improved tumble finishing machine finds application in aircraft, armaments and other metal working operations.

metal working operations to deburr and smooth rough edges and sharp corners.

Featuring Crown buffer strip lining, which is said to make possible on-the-spot replacement, the machines keep at a minimum the down-time needed for lining renewal. A variable speed drive gives the operator a wide choice of speeds for the processing of steel, die cast or other metal parts, while an automatic timer control is said to assure a definite operating time.

Rubber Conserving V-Belt

According to the inventor, *Charles F. Dean*, 25 E. Alameda Ave., Denver 9, the new revolutionary V-Belt (U. S. Patent No. 2,540,245) consumes approximately ⅛ less of strategic rubber and can outperform any solid type belt offered today.

The oustanding feature of the new belt

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● Many of America's leading manufacturers, producing a wide variety of products, are benefiting from Auto-Lite die cast research, experience and advancement. Such developments as high pressure casting, special alloying practices and improved quality through the "controlled metals process" make Auto-Lite the logical source of supply for precision die castings. Address inquiries to:

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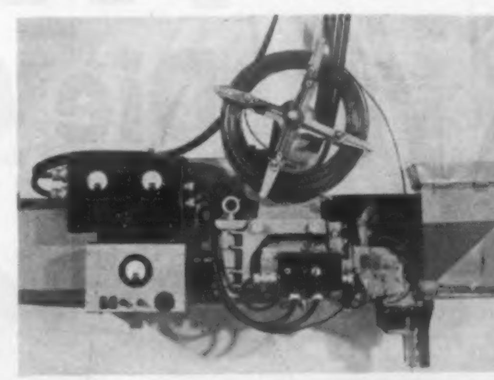
is a hollow center with an open slot leading to the outside, thus providing ventilation for cooler running and release of the inner pressure that previously had been the chief cause of breakdown and failure.

High-Speed Unionmelt Welding Machine

Uniform welding of straight-line seams in light to heavy plate can be done at high speeds with the new UE-48 welding machine designed by *Linde Air Products Co.*, 30 E. 42nd St., New York 17, according to a recent company report. The new machine consists of Linde's new



This new welding machine can be set up to fit any permanent production installation.

CM-48 side beam carriage, a UE welding head, a small rod reel, a Unionmelt feed hopper, and controls. Welding current, carriage speed, welding voltage and the Unionmelt material flow all can be adjusted before welding is begun.

The unit is equipped to handle a wide variety of work—metal from 16-gage to 1½ in. thick can be welded with a single pass.

Improved Laminated Wood Paneling

A new and completely different laminated wood paneling, which is an improved substitute for plywood, has been announced by *United States Plywood Corp*,. Weldwood Bldg., 55 W. 44th St., New York 18.

Combining the plywood principle of laminated construction with the use of resin-impregnated wood fibers, Novoply is an all wood material, said to have properties superior to those of any wood product yet developed.

Flatness, easy workability and usefulness as a core material for wood veneers, plastics or other coverings are but a few

Why pussyfoot in picking tubing?

Bundyweld Tubing, double-walled from a single strip. Exclusive, patented beveled edge affords smoother joint, absence of bead, less chance for any leakage.

No need to get yourself out on a catwalk when it comes to choosing a small-diameter tubing for your product.

Bundyweld, the multiple-wall type of Bundy® tubing, is top choice across the boards for applications ranging from radiant heating grids and automotive pressure lines to cartridges of ball-point pens. The only tubing that's double-walled from a single strip, Bundyweld is made by the world's largest producer of small-diameter tubing.

For technical help or information, contact Bundy Tubing Company today.

Bundy Tubing Company

DETROIT 14, MICHIGAN

World's largest producer of small-diameter tubing

AFFILIATED PLANTS IN ENGLAND, FRANCE AND GERMANY

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of the properties claimed for the new wood. Because of its remarkable dimensional stability, it solves the age-old sliding and cabinet door problem. In its natural state or wood-veneered, Novoply makes warp-free furniture, cabinets or built-ins of all kinds.

With all of its advantages, the new wood is said to be remarkably low in price.

Chemical Bath Removes Scale from Forgings

Forging scale is an iron oxide which is harder than steel, is very abrasive, and clings tenaciously to the forgings. If not removed completely, it interferes with machine tool setting and quickly wears down cutting tools. If left on finished parts, pieces of the scale will eventualy drop into mechanisms and wear other working parts rapidly. The removal of furnace scale is one of the most difficult problems in production heat treating of steel forgings. However, *Pennsylvania Salt Manufacturing Co.*, 1000 Widener Bldg., Philadelphia 7, is currently marketing a pre-heat chemical bath which not only removes the scale during quenching, but is said to effect a cost savings of 90% over previous methods employed.

Composed of a new product, Pennsalt SR-4, dissolved in weak muriatic acid and water, which was developed from a practice originated at the Toledo, Ohio and Pottstown, Pa., plants of the Spicer Manufacturing Div. of the Dana Corp., the bath requires no heating and is made up in ordinary rubber lined tanks. Dipping baskets can be made of simple sheet iron.

In operation, parts covered with forging scale are immersed in the bath for 5 min. and then placed directly into a heat treating furnace or stored for later heat treating. The forgings are heat treated at a temperature range of from 1500 to 1600 F and soaked at temperature for the minimum time consistent with good metallurgical practice. An additional saving is said to result from the fact that the forgings can be heated in a non-reducing atmosphere or without a prepared atmosphere.

Following heating, the forgings are water quenched and tempered. In contrast to conventional operations where tenacious furnace scale is next removed by expensive sand or shot-blasting, the use of the new bath completely eliminates this process. When the forgings treated with SR-4 are water quenched, the scale is claimed to actually blast off

Rx Take your Casting, Finishing and Assembly problems to Monarch Aluminum Mfg. Company

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Nationally-known manufacturers rely upon Monarch's outstanding facilities for casting, finishing and product assembly. Monarch operations are geared to the requirements of industry at all times.

Today, defense requirements for aluminum permanent mold, aluminum and zinc die castings require concentrated attention. Monarch is actively producing these needs. We will also apply the same facilities to help you meet important civilian production schedules.

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from all surfaces, leaving them perfectly clean for subsequent machining.

According to the manufacturer, both laboratory tests and plant operations have shown that the new bath provides for complete removal of scale from carbon steel forgings and some SAE alloys, and provides for efficient scale removal after heat treatment in most cases where oil

Tenacious scale literally blasts from the surface of steel forgings treated with Pennsalt SR-4 at the moment they are dipped in cold water.

quenches are used; in such cases where scale removal is not complete, however, sand or shot blasting operations can be reduced considerably.

Also announced by *Pennsylvania Salt Manufacturing Co.* is a new class of cleaning compositions, based on a chemical principle long known but not heretofore applied commercially in the detergent field.

Action of the new cleaners is based on oversize micelles or groups of molecules, formed by the various ingredients, which have the property of dissolving not only water-soluble soils taken up by normal soap solutions, but also water-insoluble soils which can normally be removed only by organic solvents.

Solubilizing Cleaners are claimed to have little saponifying action and do not remove fatty soils by this mechanism, and while performing somewhat like emulsion cleaners, will go far beyond these in cleaning range because of their solubilizing action. In addition, they are said to have the capacity of removing solid soils by detergent action and continue to clean effectively even when loaded with soil.

The range of solvent power inherent in the new cleaners makes them effective

New Kralastic® creates "the comb with 5 lives"

Looking for new ideas for your product? Want to make it tough—*really tough?* Want it *lighter, more rigid, better-looking, longer-lasting?*

Then look here—at what Naugatuck's new Kralastic plastic resin has done for combs. Then find out, with the coupon below, what Kralastic can mean to you.

This remarkable comb (several types pictured above) is called PRO "RESINITE" —product of the famous PROPHYLACTIC Brush Co., Florence, Mass.

Its life is longer—*as much as 5 times longer*—than combs that are manufactured with conventional materials.

And there's absolutely none of the usual comb brittleness. It has stood up to people's sitting on it—hard—without breaking! *Colorful*, too—a wide sales-winning range.

What's the catch? Cost? No, Kralastic can be *injection-molded*—assuring much *more economical* production.

New Kralastic is an ingenious combination of two copolymers, creating a *light* and *tough, rigid, dimensionally stable* material. Offers *good electricals and the advantage of high tensile* strength.

That's why so many processors and manufacturers are switching to Kralastic for pipes, gears, dials, wall moldings, tote boxes, electric switch buttons, refrigerator parts, pen parts. It will bring scores of improvements to hundreds of products.

Kralastic comes to you from United States Rubber Company's Naugatuck Chemical Division—a sound and permanent base for your product future. ***Make your Kralastic discovery today.***

Naugatuck Chemical Plastics Division, Elm St., 18,
Naugatuck, Conn.
Without charge, send technical data on properties, uses, handling methods (specify desired end products).

I understand that, from this data, I can order suitable, free experimental samples.

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MARVINOL® vinyl resins • KRALASTIC® styrene copolymers • VIBRIN® polyester resins

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in removing such complex soils as buffing compounds, greases and pigmented drawing compounds. They will be most applicable where alkaline cleaners, synthetic detergents or fortified soaps or emulsions fail to give complete soil removal.

Motor and Generator Brush for Aircraft

The *Pure Carbon Co., Inc.*, St. Marys, Pa. has announced the development of a new type of brush especially designed for operation on aircraft motors and generators. This new development embodies a combination of chemically treated and untreated brushes or sections which are combined in such a way as to put just the right amount of film on the commutator or ring to give good operation at high altitude.

In most cases, the brush is made up in a sandwich type construction, the impregnated section, which can be varied in width as required, being sandwiched between two layers of untreated materials. A method of cementing these sections together has been worked out which is said to insure against the sections coming apart. By varying the thickness of the treated section, the amount of film deposited by the brush can be controlled.

For most applications where the brush must operate at normal altitude, and in the stratosphere up to 50,000 ft a section of equal parts treated an untreated material has been found to give good results. In other cases, depending on the load, characteristics and other variables, a treated section approximately one-third of the total thickness has been indicated.

An outstanding feature claimed for this brush is that almost an exact amount of the chemical impregnation will be contained in each brush without the expense of weighing each brush.

Oxyacetylene Cleaning Process

Sand encrustations, fins, pads, chaplets or chill nails and other forms of excess metal can be removed from castings quickly, easily and economically by means of an oxyacetylene method recently developed by *Linde Air Products Co.*, a division of *Union Carbide and Carbon Corp.*, 30 E. 42nd St., New York 17.

Called Powder-Washing, the new process utilizes a special Oxweld FSC-1 blowpipe equipped with external powder-

(Continued on page 119)

New Materials and Equipment

washing attachment. In operation, an iron-rich powder is fed through oxyacetylene preheat flames into a low-velocity oxygen stream, where it burns and produces superheated liquid iron oxide. Heat from the combustion of the powder and from the slag simplifies and speeds the

This Oxweld blowpipe with powder attachment is used here to remove excess metal and encrusted sand from a casting.

removal of metal and metal-sand mixtures. Wherever the powder-fed flame is directed against a casting, the metal surface is brought quickly to kindling temperature, and then it is oxidized and blown away by the oxygen stream.

After the process, the surfaces of castings are said to be left smooth, clean and close to tolerance. There is no undercutting and no torn metal.

Rust Inhibiting Primer

Recently announced by *Carboline Co.,* 7603 Forsyth Blvd., St. Louis 5, the new rustbond primer contains two of the well known and widely used rust inhibitors—red lead and iron oxide. These, mixed with a new chromate pigment and blended with an entirely new vehicle that wets rust, are said to make the primer entirely different.

According to the manufacturer, the new vehicle enables the primer to lock paint film—particularly vinyls—to surfaces having adherent rust. Its wetting action is visible upon close microscopic inspection and becomes very evident by its ability to reduce the splitting of top vinyl finishes to nearly zero. Splitting of vinyl paint films on the edges of thin steel panels is said to be reduced from a normal 80% to 4% maximum, in an atmosphere which corrosively penetrates the thin top finishes on sharp corners.

Another important feature of the primer is that it shows evidence upon visual inspection 60 days after application on rusty surfaces of reducing portions of the rust particles from iron oxide to iron. It

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is believed that this action is responsible, at least in part, for the excellent bond obtained, as the primer performs noticeably better on rusty surfaces than on clean, shiny metal. It does not replace standard primers on new or sandblasted steel.

The third most important point about the new product is that it has been found compatible with all types of finishes tried upon it. Finishes are claimed to cling to it—not peel. With vinyls, it has been found that a tie-coat containing hydroxyl resins between the primer and the vinyl top coat gives better results than direct application on the primer itself.

Metal Analyzer

Developed to meet the industrial demand for an efficient, moderately priced metal analyzer, the new metalograph offered by *Bausch & Lomb Optical Co.*, Rochester 2, N. Y. is said to possess all the desirable benefits usually found in only the highest priced instruments.

The Balphot is claimed to give the user a bright field, dark field, polarized light and (at extra cost) phase contrast. Its Magna-Viewer permits comfortable, accurate grain-size determination and dirt counts on a screen in a normally lighted room.

Other features of the new instrument are said to include:

1. Straight-line compact operating zone for speedier examinations.
2. Rotable stage, mechanical stage with convenient dual controls.
3. Raisable stage for rapid objective changes—no coarse adjustment.
4. Swing-in filters for use singly or in combinations.
5. Convenient instant-action optical path selector.

Silver Electroplating Process for Steel

A new process for electroplating silver on steel wire and rod has been announced by *Kenmore Metals Corp.*, 380 Ninth St., Jersey City 2.

The use of silver which is not on the critical materials list for plated steel is one of the few instances where a better substitute material has been developed without decreasing quality in the finished product or tending to create a scarcity of of other material.

According to the company, the new

New Materials and Equipment

process has been worked out so that large quantities of silver plated steel wire and rod can be produced quickly and at a cost comparable to that for nickel or brass plated material. Improved continuous plating methods and precise process control permit the use of unusually small amounts of silver for a durable, decorative finish.

New Vacuum System Has Many Uses

A new vacuum system designed for a wide variety of uses in research, control and production has been announced by *RCA Victor,* division of *Radio Corp. of America,* Camden, N. J.

RCA Type EMV-5 vacuum system is claimed to serve such applications as evaporation of metals and salts, sputtering, applying metallic films, vacuum distillation, drying, preparation of specimens for electron microscopy, study of discharges in gases at low pressures and in various other related uses. It can also be used industrially for vacuum coating of many items, such as mirrors, lenses, vacuum tubes and plastic objects, on a production basis.

The new equipment consists essentially of a vacuum chamber (bell jar, base plate and terminals) and a high-speed pumping unit for evacuation. The pumping system and valving are similar to those used by RCA in the Universal Model Electron Microscopes. A mechanical fore pump and an oil diffusion pump serve to evacuate the vacuum chamber to 0.1 micron mercury (1/1000th of a millimeter of mercury pressure) in less than 7 min. A cold-cathode discharge gage is used to measure the pressure in the chamber.

High Temperature Heater

Thermel, Inc., 3440 W. Lake St., Chicago 24, has announced a new heating unit designed to enable a plastic sheeting die, 70 in. in length, to process in excess of 300 lb of material per hr at 800 F.

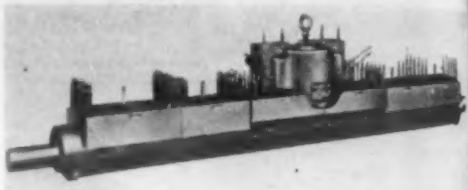
The assemblage consists of six cast-in aluminum-bronze Thermaheaters on the die proper and three cast-in aluminum-bronze Thermaheaters on the throat assembly between the extruder and the die.

Design of the heaters (the use of multiple numbers of heating elements of conservative ratings in the castings) not only affords longer life at full capacity, but is also said to offer the added advantage that for high production processing of

New Materials and Equipment

materials, such as polyethylene at the conventional temperatures of 500 to 550 F, the multiple number of elements can be connected up to operate on reduced voltage.

For polyethylene extrusion, aluminum can be used as the casting medium or for operation temperatures to 750 F. How-



This new heater is said to enable a plastic sheeting die 70 in. in length to process in excess of 300 lb of material per hr at 800 F.

ever, due to the possible processing of material at 800 F, aluminum-bronze is required as the die design, which is generally used for sheet extrusion, permits only 40% of its surface to be available for heat contact. This means that with material at 800 F, the heaters would be operating in the area of 1000 F, which would preclude the use of aluminum as the casting medium. However, in actual use on polyethylene with the control instruments set at approximately 550 F, the temperature gradient between the heaters and material is 50 F.

Aluminum Lining Pigment

A special, extra fine aluminum lining pigment said to be capable of producing films of the highest chromium-like appearance, has been announced by *Metals Distintegrating Co.*, Elizabeth, N. J.

Maximum brilliance and metallic luster are claimed to be obtained with MD 769 Aluminum Paste, which is particularly recommended for simulated chromium finishes. It provides, according to the manufacturer, a good substitute for chromium plating, and its appearance is said to be as near to chromium as is possible to obtain with a metal pigment.

Automatic Precision Tumbling Machine

Large quantities of parts are now claimed to be precision finished at one time in the new Model DW-60-36-2 automatic control precision tumbling machine recently developed by *Roto-Finish Co.*, Kalamazoo, Mich.

Compact and easily accessible for speed

...IN FLAME HARDENED OR HEAT TREATED MEEHANITE® CASTINGS

The adaptability of Meehanite castings to all the modern types of heat treatment including local flame hardening are numerous and include:

1. Improved engineering properties—tensiles up to 80,000 psi; Brinells up to 600 and toughness.
2. Maximum hardness penetrating uniformly to over ½ total depth of case.

The metallurgical structures of the higher property types of Meehanite castings are, of course, carefully regulated and respond to heat treatment uniformly with properties which can be predicted according to established procedure.

A typical example is illustrated. A Meehanite Type GA worm heat treated to 350 Brinell, ground to mirror smoothness is mated with a Meehanite Type GC worm gear. In the manufacture of certain types of mining equipment this combination is specified regularly as a result of both tests and experience in the field. Previous combinations of other materials frequently resulted in galling and scoring of the worm and resulting deterioration of the worm gears.

Properties of the worms as cast and after heat treatment are as follows:

Worm as Cast	After Heat Treatment
Tensile 55,000 psi	68,000 psi
Transverse 3400 lb.	4000 lb.
Brinell 230	350

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Builders Iron Foundry .... Providence, Rhode Island
Continental Gin Co. .... Birmingham, Alabama
Crawford & Doherty Foundry Co. .... Portland, Oregon
The Cooper-Bessemer Corp. ... Mt. Vernon, Ohio and Grove City, Pa.
Empire Pattern & Foundry Co. .... Tulsa, Oklahoma
Farrel-Birmingham Co., Inc. .... Ansonia, Connecticut
Florence Pipe Foundry & Machine Co. .... Florence, New Jersey
Fulton Foundry & Machine Co., Inc. .... Cleveland, Ohio
General Foundry & Manufacturing Co. .... Flint, Michigan
Greenlee Foundry Co. .... Chicago, Illinois
The Hamilton Foundry & Machine Co. .... Hamilton, Ohio
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Hardinge Manufacturing Co. .... York, Pa.
Johnstone Foundries, Inc. .... Grove City, Pennsylvania
Kanawha Manufacturing Co. .... Charleston, West Virginia
Lincoln Foundry Corp. .... Los Angeles, California
E. Long Ltd. .... Orillia, Ontario
Otis Elevator Co., Ltd. .... Hamilton, Ontario
The Henry Perkins Co. .... Bridgewater, Massachusetts
Pohlman Foundry Co., Inc. .... Buffalo, New York
Rosedale Foundry & Machine Co. .... Pittsburgh, Pennsylvania
Ross-Meehan Foundries .... Chattanooga, Tennessee
Shenango-Penn Mold Co. .... Dover, Ohio
Standard Foundry Co. .... Worcester, Massachusetts
The Stearns-Roger Manufacturing Co. .... Denver, Colorado
Traylor Engineering & Mfg. Co. .... Allentown, Pennsylvania
Valley Iron Works, Inc. .... St. Paul, Minnesota
Vulcan Foundry Co. .... Oakland, California
Warren Foundry & Pipe Corporation .... Phillipsburg, New Jersey

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MEEHANITE® NEW ROCHELLE, N. Y.

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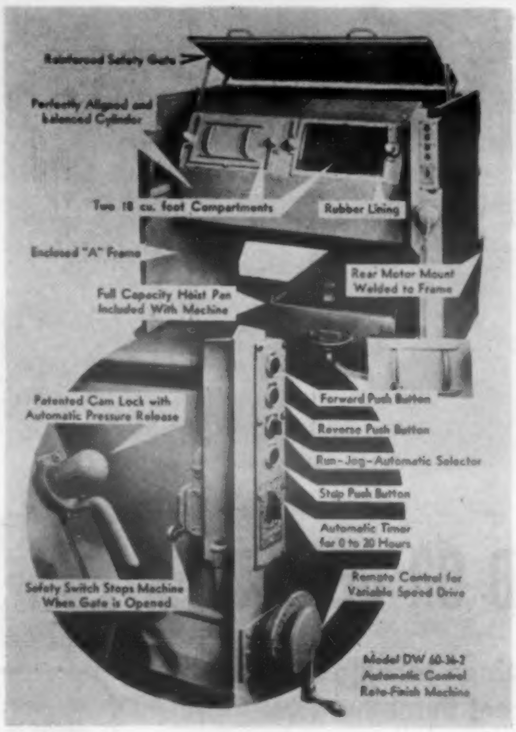
of operation and maintenance, the unit is push-button operated, having all controls conveniently located on one compact panel. It has jogging provisions and a mag-



According to the manufacturer, this tumbling machine is the largest practical standard machine of its type on the market.

netic reversing starter with 110-v control transformer. Once the machine is started, an automatic timer will stop its operation any time from 0 to 20 hr without further attention. A 5-hp variable speed power unit with a remote control handle for adjusting the speed of the cylinder from 10 to 30 rpm is another feature.

Anti-Corrosive Metal Protector

A new anti-corrosive, Corrosanti, has been announced by the research laboratory of Dr. *Adolph Schror,* 52 Cambridge St., East Orange, N. J.

Manufactured in four grades, depending upon the purpose it is intended for, the treatment is said to react upon the metal treated, and not upon the water surrounding the metal.

Grade A is the preparation for the protection of boiler metal surfaces. It is claimed to remove all boilers' scale deposits and as such is guaranteed to eliminate the necessity of any mechanical boiler cleaning device or costly water softeners.

Grade B also prevents electrolysis within the boiler and is harmless to valves, pumps, gaskets and other equipment. It is specially prepared for the protection of ferrous metals subjected to de-

New Materials and Equipment

teriorating influences of water and water vapor.

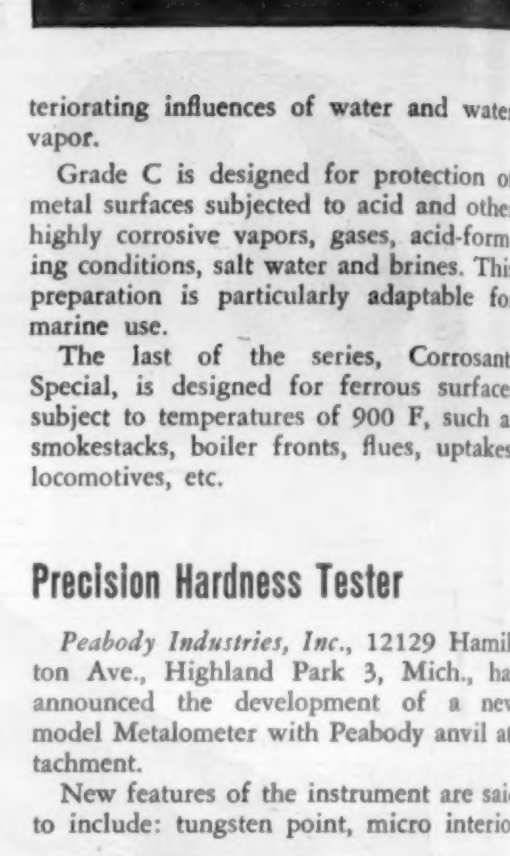
Grade C is designed for protection of metal surfaces subjected to acid and other highly corrosive vapors, gases, acid-forming conditions, salt water and brines. This preparation is particularly adaptable for marine use.

The last of the series, Corrosanti Special, is designed for ferrous surfaces subject to temperatures of 900 F, such as smokestacks, boiler fronts, flues, uptakes, locomotives, etc.

Precision Hardness Tester

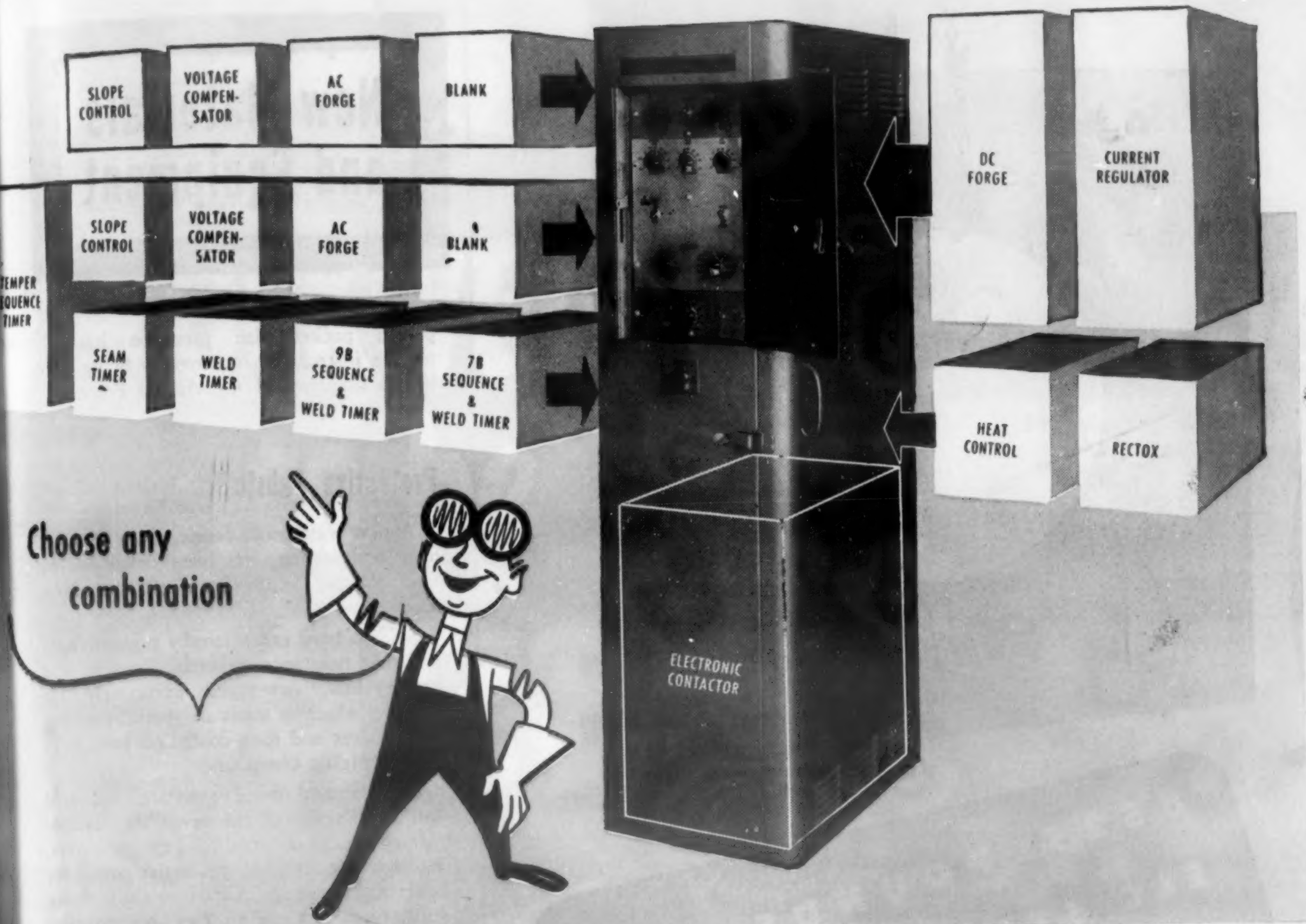
Peabody Industries, Inc., 12129 Hamilton Ave., Highland Park 3, Mich., has announced the development of a new model Metalometer with Peabody anvil attachment.

New features of the instrument are said to include: tungsten point, micro interior



This low priced precision hardness tester is currently being used by all branches of the Armed forces.

finishes and trigger release mechanism. The anvil is claimed to broaden the application of testing the surface hardness of small parts. Sheet steel, gears, castings, tool bits and drills can now be accurately checked with the anvil attachment. According to the manufacturer, the low



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Interchange these components to match production changes

Now you can keep your resistance welding control "on the line", regardless of production changes. With a Westinghouse Welding Control you merely add or substitute the necessary control components.

The Westinghouse Welding Control is built up of basic control components and auxiliary control units. Basic controls include the electronic contactor and sequence and weld timer, synchronous or nonsynchronous. Auxiliary controls include a wide range of functional units among which are: forge timer, slope control, voltage compensator and dual weld attachment. Combinations of the complete line of components can be assembled to meet the needs of practically all resistance welding techniques. All component units plug in to either a 600 or 1200-frame electronic contactor structure.

Each unit is self-contained and completely prewired at the factory. Mount the panel and insert the polarized plug—that's all it takes to make a complete change-over.

Many other advancements in control design such as the transformer-type flow switch, are built into this packaged control for resistance welding. Get the complete story from your Westinghouse representative or write for Booklet B-4309. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-27006

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RESISTANCE WELDING CONTROL

New Materials and Equipment

priced pocket size precision hardness testing instrument is currently being used by all branches of the Armed Forces.

Protective Fabric

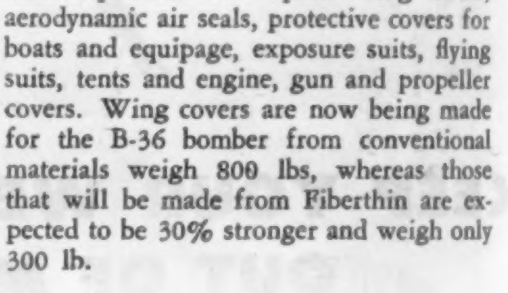
A new waterproof fabric, made of nylon fiber and plastic, has been developed by *U. S. Rubber Co.*, Rockefeller Center, New York 20.

Said to have exceptionally high strength and tear resistance, Fiberthin consists of a base fabric, developed exclusively for coating, which is made of specially woven nylon fibers and then coated on both sides with a plastic compound.

Mildew and flame resistant, oil, acid and alkali resistant, the new frabric is considered practical for airplane wing covers, aerodynamic air seals, protective covers for boats and equipage, exposure suits, flying suits, tents and engine, gun and propeller covers. Wing covers are now being made for the B-36 bomber from conventional materials weigh 800 lbs, whereas those that will be made from Fiberthin are expected to be 30% stronger and weigh only 300 lb.

Finishing Barrel for Small Lots

An outstanding feature of the ALMCO Supersheen Finishing Barrel, Model DBO-1, currently offered by ALMCO, division of *Queen Stove Works, Inc.*, Albert Lea, Minn., is the removable screening drawers which are said to facilitate separating parts from media, loading and unloading.



An outstanding feaure of this finishing barrel is its removable screening drawers.

Equipped with the variable speed drive allowing from 25 to approximately 60 rpm, the unit is complete in itself and is highly recommended for the processing of small lots of parts, the processing of

(Continued on page 134)

New Materials and Equipment

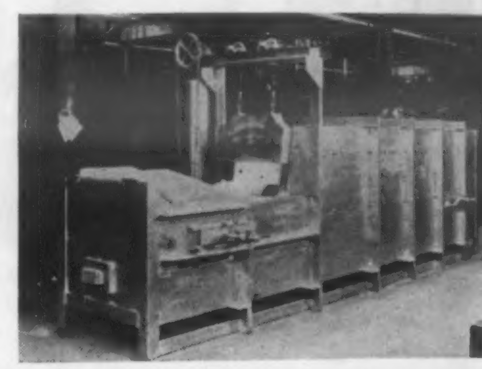
close tolerance work, and for research and development work.

Twin barrels measure 8 by 16 in. and are available with or without 1/4-in. neoprene lining. All moving parts are safely enclosed with the safety hood, and the construction is of heavy welded steel.

Continuous Electric Furnace

A continuous electric furnace for the heat treating of wrenches has been designed by *Bellevue Industrial Furnace Co.*, 2620 Crane Ave., Detroit 14.

According to the company, the unit affords a minimum of heating loss and



This electric furnace for the heat treating of wrenches affords a minimum of heating loss.

lower operating cost as the belt is entirely enclosed within the heating unit. Water or oil can be used as the quenching agent and production is 800 lb per hr.

Rust-Proofing Process

Recommended as a replacement for cadmium or zinc in many rust-proofing applications, a new phosphate coating material developed by *Detrex Corp.*, Box 501, Detroit 32, is claimed to have superior corrosion resistance.

When immersed in a solution of the material, iron and steel surfaces are chemically converted into a dark gray, uniform, dense, nonmetallic phosphate coating. After rinsing, the highly absorbent coating is impregnated with a rust-proofing oil known as Perm-Oil, thereby giving the product a permanent corrosion-proof layer that is dry to the touch.

According to the manufacturer, standard salt spray tests indicate a resistance well in excess of 36 hr required in U. S. Army Specification 57-0-2c, Type II, Class B.

Typical applications for Perm-Cote are: metal fasteners, springs, hardware and hand tools, appliances, sheet metal parts, rockets, clips and links, mortar shells, etc.

White-to-Grey Tin Formation in Refrigeration Equipment

by HERBERT S. KALISH,

Metallurgical Laboratories,

Sylvania Electric Products, Inc.

● THE DISINTEGRATION OF white tin metal to grey tin powder in refrigerating equipment may be a more common occurence than most engineers think. The use of tin should perhaps be avoided in low temperature applications—particularly where the tin is used as a plated coating in the relatively pure state.

Important research has been done in the last few years on the low temperature properties of tin and its alloys. The embrittlement of other metals with cold has been studied too, of course, but no one is certain as to what the exact causes of these low temperature defects are. The only fact that is generally accepted is that face-centered cubic metals are the only metals that remain ductile as the temperature is lowered.

While the theory is still obscure, the fact that ductile white tin turns into an extremely brittle, grey metal at low temperatures and that tin objects disintegrate into powder is well known. The tin uniform buttons worn by Napoleon's soldiers are said to have transformed in the cold of the Russian winter.

That grey tin forms in refrigerating equipment, however, has been questioned. The addition of alloying elements to tin retards the white-to-grey transformation, and soldered joints are used freely on many pieces of low-temperature equipment without fear of failure. Other applications of tin in the same equipment are also common, however, without heed to the possible transformation of the metal.

Tin can change to the grey powder form in everyday applications with reasonable rapidity. The author

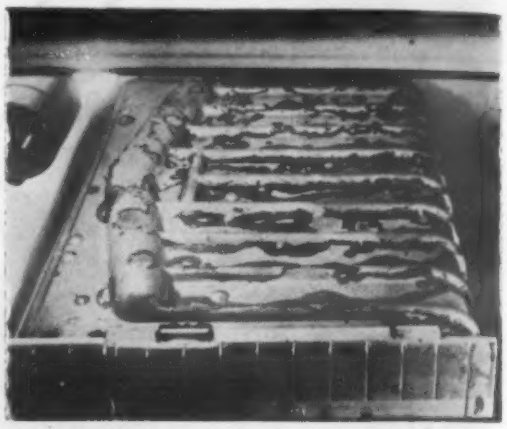
(Continued on page 138)

White-to-Grey Tin Formation

continued from page 136

found that the tin plating on the cold chamber of his home refrigerator, for example, was disintegrating and flaking off. A spectrographic analysis of the powder which had sloughed off revealed that it was very pure tin. There could be no question but that it was grey tin.

It had apparently taken nine or ten years for the process to start, but once started, it had covered nearly the entire cold chamber. With each defrost, the grey tin fell away, leaving the bare steel open to rusting.



The tin plate on the cold chamber of this home refrigerator flaked off after ten year's service due to the low temperature transition of white tin metal to grey tin powder.

An inquiry of the other people in the same apartment house revealed that this was not uncommon. The feeling of the housewives was that the grey dust was troublesome, but not too difficult to clean away.

It is possible that the author, unknowingly, brought some grey tin nuclei from the University of Pennsylvania, where the white-to-grey transformation has been studied. This could have caused the process to start. Similar cases of unusual transfers of nuclei by accident have been reported.

In any case, however, the tin transformation at low temperatures has more than just academic interest. Practical application problems warrant further investigation.

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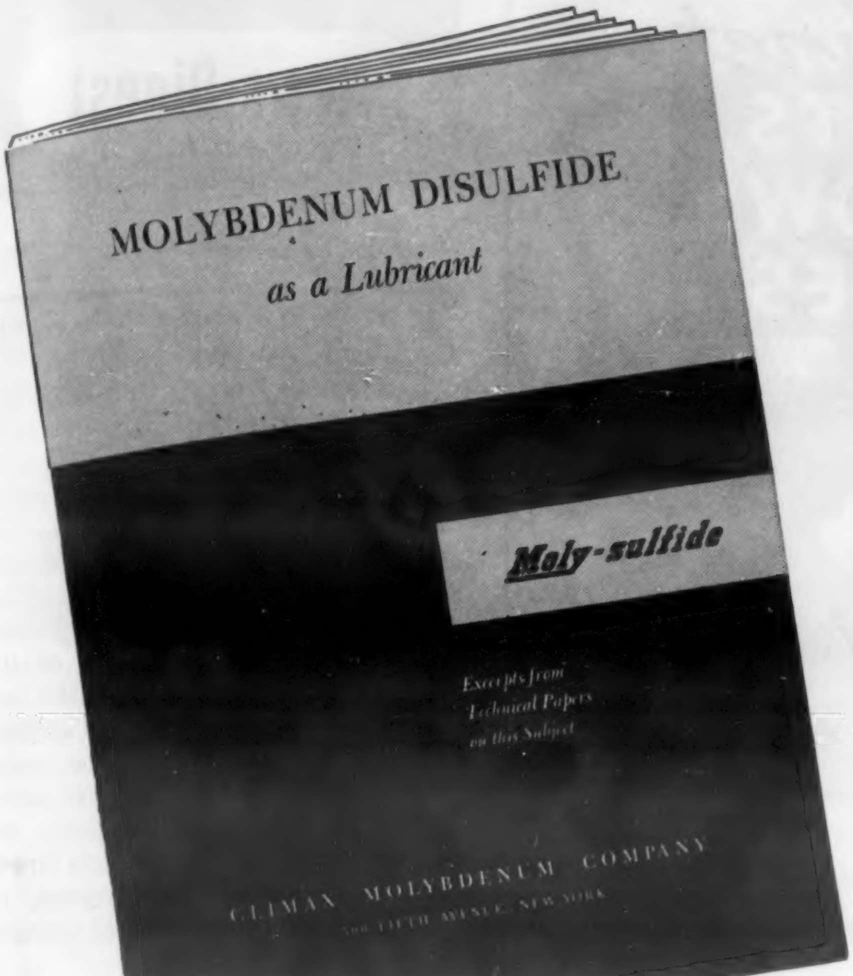
Reprints are now available of the 32-page article on "How to Overcome Materials Shortages in Product Design and Manufacture", which appeared in the July 1951 issue of MATERIALS & METHODS.



What do you know about MoS_2* as a lubricant?

* Molybdenum disulfide

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News Digest

New Devices Speed Tests

continued from page 13

was adapted from a Krouse plate bending fatigue machine. Specimens 1- by 1/2-in. wide are held in place by grooves in two horizontal arms. While the lower arm remains stationary the upper arm, pivoted at one end, is moved up and down at the other end by a crank arm and adjustable eccentric. At the top of the crank throw the arms are parallel, and the distance between the grooves equals the length of the specimens. When the upper arm is moved down by the crank, the specimens are loaded as columns and assume bowed positions. Bending is greatest, of course, for the specimen nearest the crank.

An automatic stopping device used with the machine takes advantage of the fact that after a crack forms, the specimen no longer deflects in a smooth curve. An adjustable contact assembly is clamped to the lower arm of the machine and adjusted so that the intact specimen nearest the crank just fails to touch the contact disk at its maximum deflection. Cracks tend to form near the center of the specimen, and when a crack starts, a "hinge effect" causes the middle of the specimen to deflect more and make contact with the disk. This contact operates an electronic relay, stopping the machine.

When a group of identical specimens are set up in the machine, the one nearest the crank, since it is subjected to the highest range of stress, will break first. After this specimen has been removed and the number of cycles recorded, the contact assembly is moved to the next specimen and the machine restarted. Since as many as seven specimens can be tested at once, the fatigue properties of a material can be determined over a wide range of maximum strain values in a relatively short time.

New Machine Produces Largest Injection Molded Pieces

The production of the largest thermoplastic resin molded products ever made in one piece is now being accomplished with new 300-oz injection

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One thing is sure: Your use of a D-H product will prove a source of confidence—confidence not only in Driver-Harris products per se, but, in a wider sense, confidence in the capacity of creative America to meet any situation, *come what may.*

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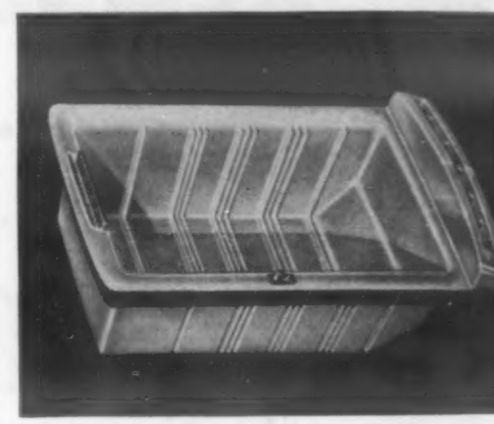
News Digest

molding machines. The new machines go a long way toward overcoming one of the major limitations of injection molding—the fastest, most economical production method for thermoplastics—by providing a substantial increase in capacity. Built by the Watson-Stillman Co., they have greatly added to the productive capacities of at least two companies: Amos Plastics Div., Amos-Thompson Corp., and Ideal Plastics Corp.

The new presses are about five times the rated size of any others now in operation. They make possible the one-piece molding of thermoplastic materials into such items as refrigerator liners, washing machine tubs, television cabinets, bathtubs and appliance housings, as well as many military items. In addition to their ability to produce pieces beyond the capacity of smaller machines, they can produce more smaller pieces per shot by using molds with a greater number of cavities.

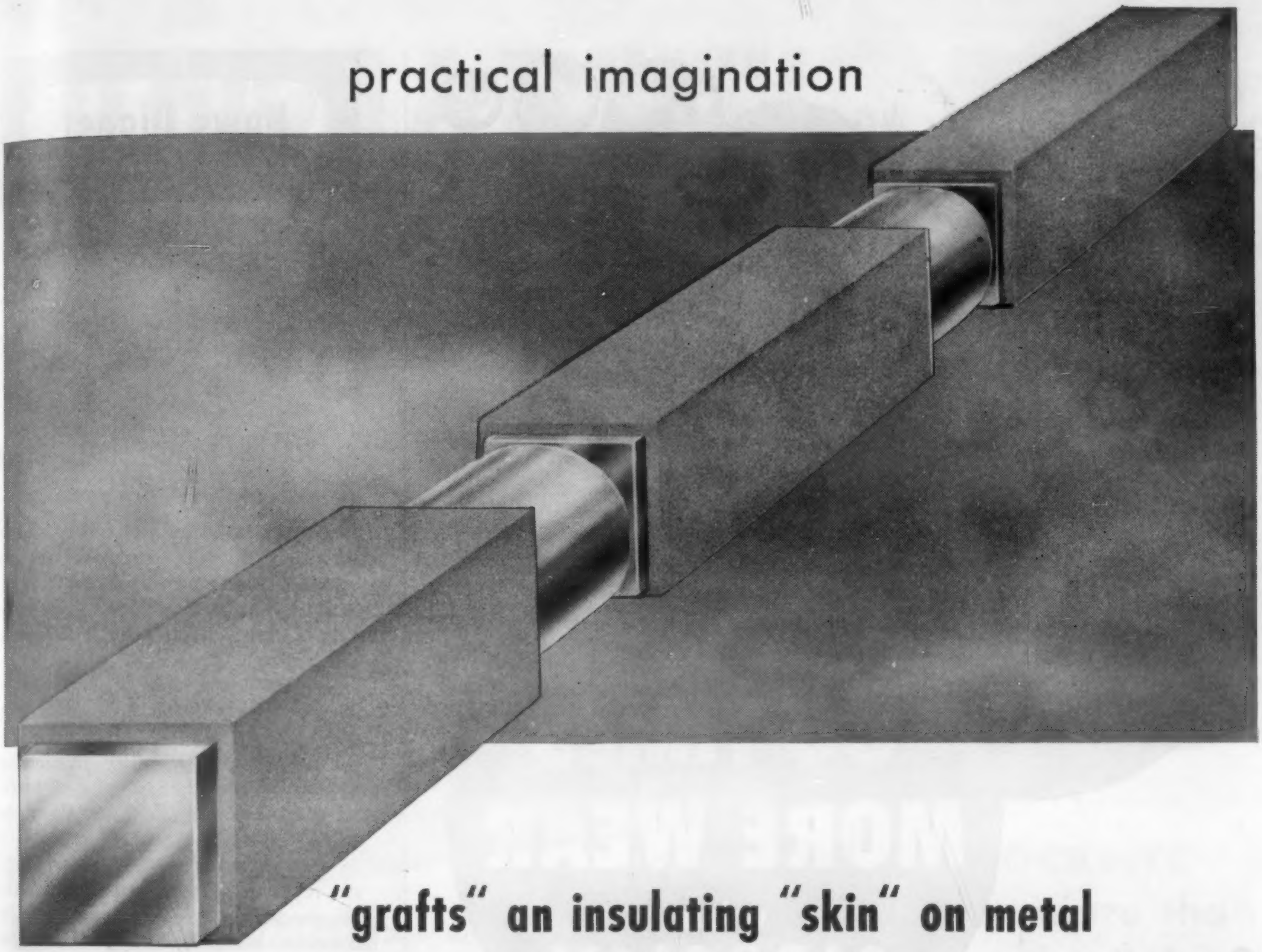


One-piece refrigerator liner now being produced by the new machine.

Of conventional design, the presses attain a clamping force of 1500 tons utilizing an auxiliary ram. This is applied to the 4- by 6-ft platen area to give a clamping pressure said to be much lower than those of smaller presses. Facilities are also provided for controlling the mold temperature more closely than is necessary with smaller machines. The mold is heated with steam coils at the time the plastic is injected to prevent the charge from cooling before it has filled the cavity. The temperature can then be lowered by means of cooling water.

The present 300-oz machines are the latest step in a rapid increase in the size of injection molding presses from the 4-oz maximum capacity available 15 years ago. As such, they have opened new fields for thermoplastics by further enlarging the list

practical imagination



"grafts" an insulating "skin" on metal

Here is another example of the practical imagination C-D engineers can put to work to solve your problems. In this case a heavy electrical connector had to be covered with a safe, efficient insulation. The material best suited to do the job was C-D Dilecto.

The next requirement was to make this insulation an integral part of the whole piece. Here is where practical imagination went to work. The solution was to laminate and mold the Dilecto directly on the metal bar.

When you have a problem involving plastics—whether it is simple or complex—be sure to check with C-D engineers for a practical, unbiased recommendation. They can choose the material best suited to your needs from a wide range of grades of five basic plastics to give you any combination of mechanical, electrical or chemical characteristics. A call to your nearest C-D office will bring you this kind of help any time—all the time.

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of parts that can be molded in one piece. While the new machines are the largest yet built, the builders see no reason why presses twice as large, if not larger could not be built if required by industry.

New Magnetic Alloy Developed by G-E Scientists

A cobalt-platinum magnet, which in small sizes is described as the world's most powerful permanent magnet, has been developed by scientists of the General Electric Research Laboratory.

Present commercial use of the new magnet will be limited, however, not only by government restrictions on the use of cobalt, but by prohibitive expense of the large amounts of platinum used in the alloy, the scientists said.

They do not foresee the new magnet replacing presently used magnetic alloys, such as the Carboloy Alnico magnets, but rather believe that new fields of use will be opened, for which existing magnets are not suitable.

Compared with Alnico-5 magnets, generally rated as the most powerful in commercial use, the new magnet is less powerful in large sizes but more powerful in small sizes, according to the scientists.

Laboratory experiments with a new magnet about the size of an eraser on a lead pencil, and a similar sized Alnico-5 magnet, show the new magnet to have lifting power 24 times greater than that of Alnico-5, and about eight times more resistant to demagnetiziation.

Magnets are limited in size by their tendency to demagnetize themselves if opposite poles, which are at the ends of the magnet, are brought too close together by cutting the magnet shorter and shorter. The new magnet has a strong resistance to this tendency. This resistance to demagnetization, called coercive force, enables the cobalt-platinum magnet to be more efficient in smaller sizes than any permanent magnet now in commercial use.

Other advantages of the new magnet are its ductility, or ability to be drawn into wire or thin sheets, and its comparative ease of machining. Alnico magnets can be machined only

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- **Dies compress the metal against a mandrel, tending to iron out small irregularities on both the inside and outside surfaces. The metal flows from high spots in the same manner as when it is forged.**
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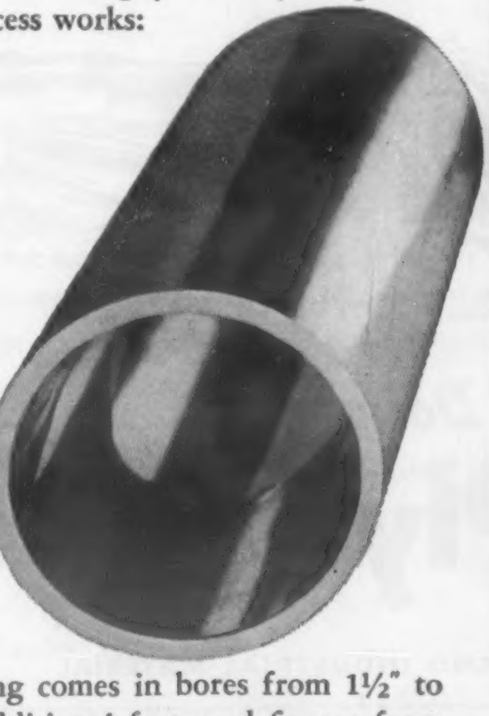
- **In no part of this operation is there any action which can produce longitudinal scratches. The metal is not drawn through a die and over a mandrel.**



SIZES? Rockrite cylinder-finish tubing comes in bores from 1½" to 5½", depending on wall thickness. Get additional facts and figures from Joseph T. Ryerson & Sons Company, Chicago, national warehouse distributor, or write us direct.

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with great difficulty, the scientists said.

Early work on the new magnetic alloy was first done by German scientists in 1935. However, Dr. A. Geisler and Dr. D. L. Martin, of the G-E Research Laboratory, say they have greatly improved the magnetic properties of the alloy over those attained by the Germans.

Symposium on the Mechanical Properties of Metals at Low Temperatures

More than 150 leading metallurgists and metallurgical engineers attended the Symposium on the Mechanical Properties of Metals at Low Temperatures held at the National Bureau of Standards in Washington, D. C. This was the second in the series of 12 symposia to be held in celebration of the 50th anniversary of the NBS, and papers on recent research were presented by representatives of industry, universities and Government. The program was under the joint chairmanship of Thomas G. Digges and George A. Ellinger of the NBS Metallurgy Div.

For several years the National Bureau of Standards has been conducting an extensive investigation of the influence of low temperatures on the mechanical properties of metals. Results obtained thus far in the program have provided a great amount of useful information on the effect of composition, heat treatment and other variables.

The opening paper of the Symposium, "Mechanical Properties of High-Purity Iron-Carbon Alloys at Low Temperatures", by R. L. Smith, Professor G. A. Moore, and Professor R. M. Brick of the University of Pennsylvania, summarized the effects of carbon content within the range of 0.05 to 0.5%, on tensile properties and on natural stress-strain curves at temperatures from –301 F to room temperature. Increases in carbon content resulted in increases in stresses at yield points, in flow stresses at constant strain and constant temperature, and in fracture stresses. Decreases were noted in total strain at fracture. The transition temperature, based on the energy required to fracture tensile specimens, is about –256 to –274 F

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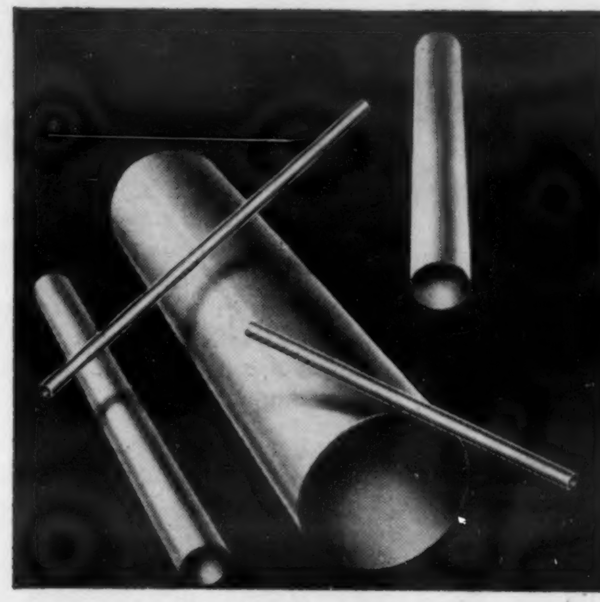
and is independent of the carbon within the above range.

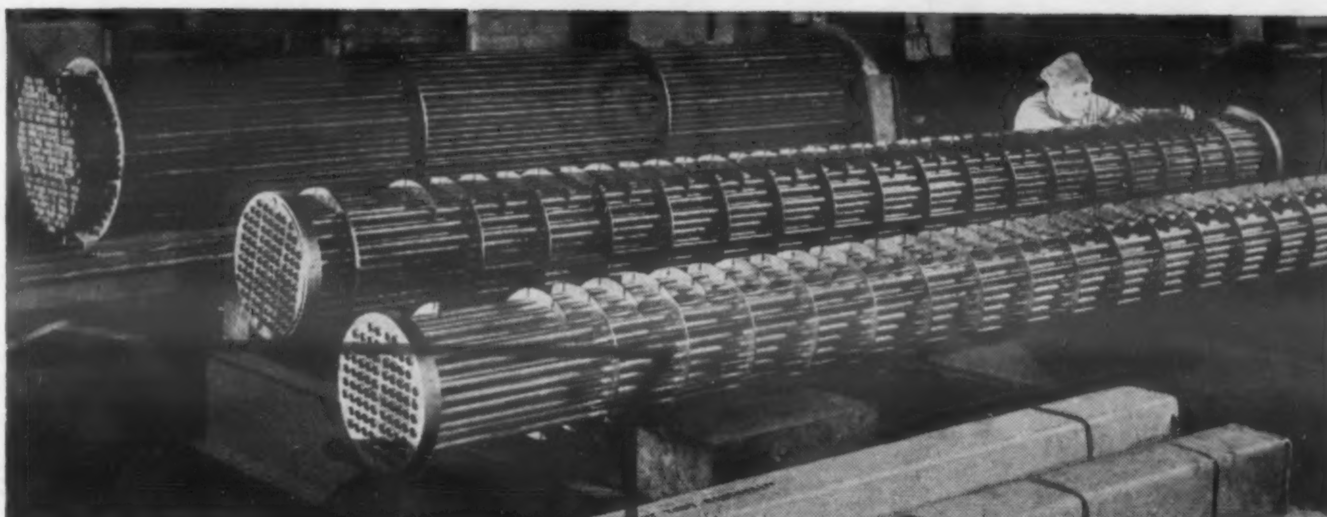
A paper, "Brittle Fracture in Ship Plates," presented by Dr. M. L. Williams of the National Bureau of Standards, showed that although failures have been reduced by improvement in design details and welding workmanship, many failures are traceable to the quality of steel, especially with respect to the notch sensitivity as measured by the 15 ft-lb transition temperature in Charpy V-notch tests. Notch sensitivity was found to increase with increase in carbon, phosphorus, molybdenum or arsenic content and grain size and to decrease with increase in silicon, manganese, copper or nickel content. The combined effects of these elements were shown not to be simply additive.

Dr. N. P. Allen of the National Physical Laboratory, England, described "Recent European Work on the Mechanical Properties of Metals at Low Temperatures". An account was given of research in Europe since 1940, including the effect of low temperatures on the following: behavior of common engineering metals and alloys; elastic constants; mechanisms of slip; brittle fractures of ferritic alloy steels as affected by alloy content, heat treatment, etc. Special attention was given to work at the National Physical Laboratory on the effect of carbon, oxygen, manganese, and combinations of these elements on the low-temperature properties of high-purity iron (99.96% iron).

A discussion of "The Manufacture of Steels for Low-Temperature Service", by Dr. J. B. Austin of the U. S. Steel Co., pointed out many of the salient factors necessary for the production and processing of steels suitable for low-temperature service. Among these were fine grain size; suitable microstructure (in ferritic steels, a tempered martensitic structure of desired hardness level is preferable to a pearlitic structure of the same hardness level); complete deoxidation of steel, preferably with aluminum; and addition of certain alloying elements. The choice and amount of the beneficial alloying elements, however, depend upon precise service conditions and economic factors, such as availability and cost.

A paper on the "Development and Application of Chromium-Copper-Nickel Steel for Low-Temperature





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Service", by Walter Crafts and C. M. Offenhauer of Union Carbide and Carbon Research Laboratories, Inc., presented data showing how a normalized low-alloy steel suitable for low-temperature service down to −148 F was developed by the addition of approximately 0.5% each of manganese, copper, nickel and chromium. Emphasis was placed on the beneficial effect of deoxidation with aluminum to assure fine grain size; increasing the residual aluminum content to approximately 0.2% gives an additional improvement, thus producing a steel suitable for use at slightly lower temperatures.

A study of "The Properties of Austenitic Stainless Steels at Low Temperatures" was given by Dr. V. N. Krovobok of The International Nickel Co., Inc. Data on the effect of low temperatures on the modulus of elasticity, ductility, fatigue, impact, tensile impact, tension, and other mechanical properties were summarized. The effect of cold-working at low temperatures and the beneficial effect of low temperatues on ductility characteristics were discussed in detail. The beneficial influence of the low carbon content of these alloy steels on their mechanical properties at low temperatures was also described.

A paper on the "Application of Metals in Aircraft at Low Temperatures", by J. B. Johnson and D. A. Shinn of Wright-Patterson Air Force Base, discussed briefly the relationship of the properties of metals as determined by conventional laboratory tests and those selected by the designer. Data on tests of aircraft metals at temperatures down to −420 F were given. Use of a steel with a higher content of strategic alloying element than is necessary for the specific application was discouraged.

In a paper on "Dimensional Effects in Fracture", Professors C. W. MacGregor and N. Grossman of Massachusetts Institute of Technology, discussed the influence of specimen size and the effect of various ratios of combined stresses on the transition temperature from ductile to brittle fracture. Slow bend tests were made at various temperatures with flat circular disks of 0.95% carbon steel simply supported around the circumference and loaded by a concentric force at the center; the results indicated that the size effect in ratio

ranges of 6 to 1 was insignificant when similitude of specimens and test conditions was maintained. Other experimental data indicated that the transition temperature of this steel increases about 60 F as the biaxial stress ratio is varied from 0.483 to 1.0.

The closing paper, "Tensile Properties of Copper, Nickel and Some Copper-Nickel Alloys at Low Temperatures", by G. W. Geil and N. L. Carwile of NBS, discussed the results of tension tests made at temperatures ranging from 212 F to —321 F. Graphs of true stress vs strain did not exhibit the commonly accepted parabolic relationship. The initial and ultimate strengths, true stresses at maximum load and at initial fracture, were shown to increase continuously with decrease in temperature. The true strain at maximum load increased slightly with decrease in temperature, but no significant change in the strain at fracture was observed. In general, the rates of work hardening at specific true strains increased with decrease in temperature and, in the case of the alloys, were affected greatly by their compositions.

An interesting motion picture on the transformation of white (B) tin to the grey (a) form at –4 F was shown. This picture, which was filmed by the University of Pennsylvania, was narrated by Dr. M. J. Disckind of the Franklin Institute.

Plastics Engineers Offer Prizes for Technical Papers

Henry M. Richardson, DeBell & Richardson, Chairman of the SPE Prize Paper Contest Committee, has announced that Carl J. Frosch of Bell Telephone Laboratories will serve as Chief Judge in the Third Annual SPE Prize Paper Contest, for which entries are now being received. The contest, designed to encourage the younger members of the Society in the preparation of technical papers contributing to the advancement of the plastics industry, offers prizes totaling $350. Local prizes, which vary at the different chapters, will swell the total winnings of successful contestants.

The judges serving with Mr. Frosch are: Herbert S. Spencer, advertising manager, Durez Plastics and

News Digest

Chemicals, Inc.; Dr. Ralph K. Witt, John Hopkins University; George S. Nalle, Jr., president, Nalle Plastics, Inc.; and Sven K. Moxness, Minneapolis-Honeywell Regulator Co.

This year's contest, like those previous, will be conducted first on a local, and subsequently on a national basis. All entries are to be submitted to the section officers, who will arrange for the judging of all papers received by the chapter. In some instances, prizes offered by the local chapter equal or exceed those in the national contest. Winners in the national contest, selected from top papers from each section, are to be announced at the Annual Technical Conference, Jan. 16-18, 1952, in Chicago. Rules for entries are simple, with no limit on length and little restriction on subject matter except that it must be on a topic pertaining to the plastics industry. Deadline for the submission of entries to the sectional contests is Oct. 15, 1951.

Complete details may be obtained from Society of Plastics Engineers, Security Bank Bldg., Athens, Ohio.

Nodule Method Measures Adhesion of Electrodeposits

A simple, inexpensive method for determining the adhesion of commercial electrodeposited coatings has been recently developed by Abner Brenner and Virginia Morgan, of the National Bureau of Standards. The new technique involves the electrodeposition of an adherent, mushroom-shaped nodule on the surface of the coating to act as a grip for the application of a detaching force. The force required to pull off the nodule—together with a portion of the coating—is then obtained on a spring balance in ordinary mechanical units.

The technique developed by NBS overcomes most of the difficulties associated with the other methods. Perhaps the greatest problem has been that of gripping a thin coating in such a way as to apply a pull sufficient to detach it from the basis metal. This difficulty was solved by the formation of the mushroom-shaped projection on the coating under study. First, all of the plated surface is covered with a lacquer. Then several small areas, about 1/16

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in. in dia, are defined by plastic washers having tapered holes. The lacquer is removed from these small areas and the nodules are built up by plating the uncovered areas in a cobalt solution. After removal of the plastic washers and stop-off material, the nodules are gripped in a chuck attached to a spring balance and detached by exerting force through the spring. The nodule always removes the initial coating, occasionally along with some of the basis metal if adhesion is high. From the reading of the spring balance and measurement of the area of the base of the nodule, the adhesive force per unit is computed

In order that the results of the test can be expressed in pounds per square inch, the area from which the nodule was detached must be determined because this area may differ somewhat from the nominal area of the hole in the plastic washer. A gage made of transparent material and containing a series of circles of varying diameter has been found to estimate the area with sufficient accuracy.

The adhesion which can be measured by the NBS method is limited only by the strength of the cobalt nodule. As electrodeposited cobalt has a tensile strength of about 75,000 psi, the test should be satisfactory for measuring the adhesion of most commercially plated coatings. So far it has not been possible to measure the adhesion of bright nickel coatings because the cobalt nodule does not adhere tenaciously enough to the bright nickel. However, NBS is now making efforts to devise a procedure for obtaining the necessary degree of adhesion. Another possible disadvantage is the time which a skilled technician must spend in making the test. Ordinarily, if the nodules are deposited overnight, one skilled operator can prepare and test about ten specimens each day.

ASM Plans World Metallurgical Congress

Metal resources will be thoroughly discussed by top-ranking metallurgists from the free nations of Europe, Africa and Asia, as well as from

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North and South America, when they gather in Detroit, Mich., Oct. 14 through the 19th to attend the World Metallurgical Congress, the first international conclave of its kind.

More than 500 conferees from more than 20 countries will assemble to exchange ideas with thousands of American metallurgists who will participate in the World Metallurgical Congress, according to Walter E. Jominy of Detroit, staff engineer of The Chrysler Motor Corp. and president of the American Society for Metals, which is sponsoring the world scientific meeting concurrently with the 33rd annual National Metal Congress and Exposition.

The full support of the Economic Cooperation Administration of Washington, D. C., had been extended. A technical assistance program covering visits of delegations of metal scientists from ECA countries has been established by the economic agency as the result of a request from the Organization for European Economic Cooperation. This is by far the largest technical assistance program yet undertaken by the ECA.

The foreign visitors are to arrive about Sept. 15. They will spend approximately five weeks in the United States. During the first four, they will be divided into eight groups participating in a series of study tours to industrial, government and educational institutions to observe at first hand the scientific, industrial and educational advances that have taken place in this country during the past few years. Some 150 plants in 13 states and 57 cities are to be visited.

By action of the Board of Trustees of the American Society for Metals, Dr. Zay Jeffries, of Pittsfield, Mass., retired vice president of the General Electric Co., a past president of the American Society for Metals, a world renowned author, scientist and a member of the National Academy of Sciences, has been appointed Director General of the World Metallurgical Congress.

The industrial study tours planned for the visiting scientists and metal executives are being arranged in eight categories of the metal industry, namely: (1) steelmaking and refining; (2) nonferrous refining, rolling and fabrication (copper, brass, bronze, aluminum, magnesium); (3) ferrous rolling, forging and hot work

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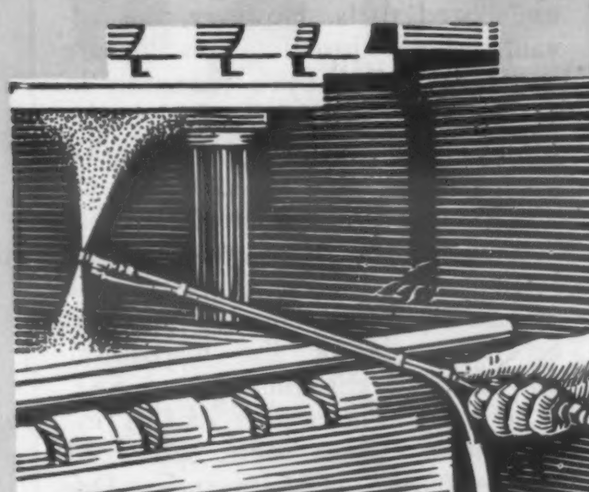

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in steel mills and heavy industry; (4) stamping, cold work, machining and finishing in lighter industry; (5) heat treatment; (6) welding and joining; (7) inspection and testing; and (8) research, engineering societies and universities.

In Detroit, visiting conferees will each have an opposite number—an American whose technical, scientific or business interest closely parallels his own. They will meet in special session in Detroit to exchange ideas and present scientific papers dealing with metals.

Plastic Deformation of Chromium-Plated Steel for Aircraft

Chromium plating, because of its hardness and ease of application, is widely used on all types of machine elements to protect softer metals from wear and to salvage worn or undersized parts. However, the advantages of chromium plating are sometimes offset by a reduction in the ability of the basis metal to deform plastically without breaking. To learn more about the effect of chromium plating on the plastic deformation of steels used in aircraft, Hugh L. Logan, of the National Bureau of Standards, recently made a comprehensive study of the mechanical properties of chromium-plated SAE 4130 steel. The results of this investigation, which were sponsored by the Bureau of Aeronautics, Department of the Navy, provides information of interest not only to aircraft manufacturers but also to a number of other industries which produce or utilize chromium-plated machine parts.

The NBS investigation included tensile, tensile impact, bending and crushing tests of specimens prepared from rod and tubing of SAE 4130 chromium-molybdenum steel heat treated to a hardness of about 40 C Rockwell scale before the final machining. Some of the specimens were tested as machined, without plating; others were tested after plating to one or more thicknesses; and still others after both plating and subsequent baking at various temperatures up to 440 C. The effect of baking was of interest since the usual commercial practice is to bake chromium-plated steel articles at a temperature

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of 200 C for several hours after plating.

The data obtained in all except the tensile impact tests indicate that chromium plating appreciably reduces the plastic deformation that can occur in SAE 4130 steel before fracture. Generally, however, the ability of the plated specimens to undergo plastic deformation was substantially increased by baking at temperatures between 100 and 440 C.

It is possible that hydrogen deposited with the chromium during plating may be a factor in reducing the amount of plastic deformation that the steel can withstand before fracture. Baking of plated specimens removes hydrogen from the chromium and, hence, may be expected to increase the ability of the steel to withstand plastic deformation.

News of Engineers

Fred H. Haggerson, president of Union Carbide and Carbon Corp., has been elected chairman of the board of directors, according to a recent company announcement.

The election of two new vice presidents by the American Can Co. and the elevation of two vice presidents to new executive positions has been announced by the company president. *T. E. Alwyn,* general manager of sales, has been elected vice president in charge of sales; *R. F. Hepenstal,* former assistant general manager of manufacture, has been elected vice president in charge of manufacture; vice presidents *L. W. Graaskamp* and *R. C. Taylor,* heretofore in charge of sales and manufacture, will work directly with the principal executive officers in the overall administration of the company.

Joseph L. O'Brien, sales manager of Doehler-Jarvis Corp.'s Chicago Div., has been appointed consultant to the office of Price Stabilization. *William L. Huber,* formerly a member of the Division's sales staff, succeeds Mr. O'Brien.

The election of *John R. Wanamaker,* great grandson of the late John Wanamaker, to the board of directors of Henry Disston & Sons, Inc., has been announced by the company. Mr. Wanamaker is trustee, director and vice president of the Wanamaker organization, and a director of both the Liberty Title and Trust Co. and the Trenton-Princeton Traction Co.

General Electric Co. has announced the

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appointment of *G. Arthur Gustafson,* former manufacturing engineer of the Chemical Dept.'s Manufacturing Div., as manufacturing and materials engineer of the Plastics Div. of the Chemical Dept. Mr. Gustafson will also be in charge of mold manufacture. Another announcement by the company names *Edward J. Riley* as manager of employee relations for the Schenectady Works. Mr. Riley, former assistant manager, succeeeds *Wendell M. Nelson,* who is retiring after 39 years with the company. Also reported by the company were the appointments of *Gordon E. Walter* as assistant division engineer of the company's Specialty Transformer Engineering Div. at Fort Wayne, and *Carl W. Moeller* as assistant to the manager of engineering at the company's Fractional Horsepower Motor Divs. at Fort Wayne.

Appointment of *George A. Lewthwaite* as general manager of the Pioneer Central Div. of Bendix Aviation Corp. has been announced by the company. Formerly sales manager for the company's Eclipse-Pioneer Div., Mr. Lewthwaite will be succeeded by *Charles F. Wolf,* chief sales engineer for the Division.

Robert W. Suman has been named chief engineer for the Link-Belt Co.'s Philadelphia plant. Mr. Suman who has been chief engineer for power transmission products since 1946, replaces *William S. Campbell,* who is retiring.

L. R. Williamson has joined Struthers Wells Corp. as consulting engineer in the Machinery Div. Mr. Williamson has previously been associated with E. W. Bliss Co., Toledo Machine Tool Co., and the Pennsylvania Railroad.

The appointment of *Andrew M. Kennedy, Jr.,* purchasing agent for the Sharon Transformer Div., as director of purchasing in charge of steel procurement for Westinghouse Electric Corp. was recently announced by the company. Dr. *Arthur W. Wishart,* vice president of the McKee Glass Co. has joined Westinghouse as manager of the newly organized Glass Manufacturing Div.

Appointment of *Clarence G. Merritt* as chief metallurgist of the Research & Development Divs. of Olin Industries' Winchester Repeating Arms Co. was recently announced by the company.

St. Joseph Lead Co. has announced the election of *Rene J. Mechin* and *Charles R. Ince* as vice presidents of the company. Mr. Ince was advanced to the office from a former position as metal sales manager.

The election of *Hector P. Boncher,* general manager of Dresser Manufacturing Div., one of ten operating companies of Dresser Industries, Inc., as vice president of the company was announced by the company's president at the annual election of officers. Other officers re-elected at the

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board meeting were: *H. N. Mallon*, president; *J. B. O'Connor*, executive vice president; *R. E. Reimer*, vice president, secretary and treasurer; *C. Paul Clark*, vice president; *Arthur R. Weis*, vice president; *M. H. Nelson*, assistant secretary and assistant treasurer.

Joseph Markowski, formerly industrial engineer for the Consolidated Vultee Aircraft Corp., has been named assistant managing field engineer for the Work-Factor Co., management consultants.

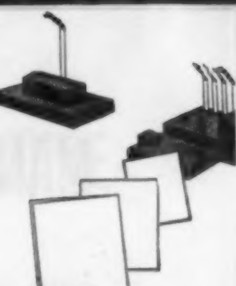
The Hays Corp. has announced the appointment of *John R. Heming* to the position of project engineer in charge of combustion control.

Allis Chalmers-Manufacturing Co. has announced the following elections and appointments within its organization. At a recent board meeting, *W. A. Roberts* was re-elected president and Boyd S. Oberlink, who has been serving as assistant to the vice president in charge of the Tractor Div., was named vice president. Re-elected as officers were: *W. C. Johnson*, executive vice president; *John Ernst*, vice president in charge of manufacturing, Tractor Div; W. E. Hawkinson, secretary and treasurer; Dr. *H. K. Ihrig*, vice president in charge of research; *J. A. Keogh*, vice president and comptroller; *F. S. Mackey*, vice president in charge of manufacturing, General Machinery Div; *J. L. Singleton*, vice president in charge of the Tractor Div; *H. W. Story*, vice president and general attorney; and *A. H. Van Hercke*, vice president in charge of engineering, Tractor Div. *E. H. Brown*, vice president in charge of engineering development, has been placed on a temporary leave of absence. Organization of a new Mechanical Power Dept., headed by *W. A. Yost*, has also been announced by the company. Manager of the organization's Steam Turbine Dept. since 1947, Mr. Yost has served on the War Production Board Industry Advisory Committee for the land steam turbine and turbine-generator industry in World War II. Other releases from the company announce the appointment of *J. F. Roberts* as director of engineering and *R. C. Allen* as consulting engineer of the General Machinery Div. Both men are widely recognized for their outstanding engineering achievements.

Herbert B. Clark was elected a director of Fansteel Metallurgical Corp. at a recent stockholders' meeting. Mr. Clark previously held the position of general manager of Vascoloy-Ramet Corp., a Fansteel subsidiary.

The American Car and Foundry Co. has announced the resignation of *Charles J. Hardy, Sr.* as director, chairman of the board and a member of the executive committee. *John E. Rovensky* was elected chairman of the board to succeed Mr. Hardy, while *Charles J. Hardy, Jr.* was

(Continued on page 173)



MANUFACTURERS' LITERATURE

Materials

Irons • Steels

Steel Sheets and Wire. Continental Steel Corp., 20 pp, ill. Specifications and description of wide range of steel sheets and wire. Includes handy tabular aids to specification. (1)

Steel Products. Crucible Steel Co. of America, 12 pp, ill. Industrial ads describing Crucible products, their uses and advantages. (2)

Steel Analyses Chart. Globe Steel Tubes Co., No. 333. Tabulation of stainless steel analyses as produced by various manufacturers showing applications of each. (3)

Gray Cast Iron. Gray Iron Founders' Society, Inc. Booklet gives mechanical and engineering characteristics of gray cast iron. Includes details for designing cast components. (4)

Low Alloy Steel. Inland Steel Co. Data on easy-to-fabricate Hi-Steel, strong, abrasion and corrosion resistant structural steel with high fatigue strengths. (5)

Ductile Iron. International Nickel Co., Inc. Data on properties, fabricating qualities and uses of ductile iron. (6)

Abrasion Resistant Alloy. Jones & Laughlin Steel Corp., 36 pp, ill, No. AD155. Mining and earthmoving applications of Jalloy, abrasion and impact resistant steel. Gives technical data. (7)

Steel Data. Joseph T. Ryerson & Son, Inc., 250 pp. Much helpful data on steel specifications and comparisons, tolerances, weight and various other subjects. (8)

Stainless Clad Steel. Alan Wood Steel Co., No. D-97. Properties and applications of Permaclad stainless clad steel affording surface characteristics of stainless steel, formability of carbon steel. (9)

Nonferrous Metals

New Brass Products. The American Brass Co., 4 pp, ill, No. B-39. Describes copper alloy sheet, strip, wire, rod and tubing treated to give outstanding physical and fabricating properties. (10)

Lead-Base Babbitt. The American Crucible Products Co. Data sheets on properties and applications of Promet XXX, lead-base babbitt said to have qualities superior to tin-base babbitts. (11)

Beryllium Copper. The Beryllium Corp., 7 pp, ill. Information on the use of beryllium copper for low cost plastics molds describing advantages and mold production methods. (12)

Low Temperature Melting Alloys. Cerro de Pasco Corp. Technical data and applications of Cerro low temperature melting alloys useful in many phases of industry. (13)

Magnesium Forms. Dow Chemical Co., Magnesium Div. Technical information on magnesium, its available forms and applications. (14)

Nickel Alloy Products. Driver-Harris Co., 4 pp, ill. *D-H Alloy Craftsman* describes various applications of Nichrome and monel wires and forms. (15)

Aluminum Alloy. Federated Metals Div., 4 pp, ill. Features, foundry characteristics and mechanical and physical properties of Tenzaloy, high strength aluminum casting alloy. (16)

Aluminum Sheet Fabrication. Kaiser Aluminum and Chemical Sales, Inc., 3 pp. Chart suitable for posting in shops indicates minimum recommended radii for the proper bending of aluminum sheet. (17)

Nonmetallic Materials • Parts

Rubber Parts. Acushnet Process Co., New Bedford, Mass. *Rubber Handbook* shows variety of rubber parts company can make to order. Request on company letterhead direct from Acushnet.

Felts. American Felt Co. "SAE Felts" gives technical standards on felt materials as adopted by automotive industries and used by many others. (18)

Extruded Plastics. The Anchor Plastics Co., 8 pp, ill, No. AP51. Shows numerous applications of extruded thermoplastics and brief characteristics to aid in selection. (19)

Polyethylene Resins. Bakelite Div., 24 pp, ill, No. V-2. Detailed data on development of polyethylene, its uses, properties and available forms and fabricating methods. (20)

Compounded Elastomers. Chicago Rawhide Manufacturing Co., 32 pp, ill. Characteristics, properties and engineering applications of Sirvene compounded elastomers. (21)

Plastics Fabrication. Continental Can Co., Plastics Div., 28 pp, ill. Describes this company's facilities for the forming and fabrication of thermosetting, thermoplastic and laminated plastics. (22)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 169.

Glass Electric Products. Corning Glass Works, 8 pp, ill, No. B-88. Electrical applications of various types of glass. Includes tables of electrical and physical properties. (23)

Molded Plastics. Dayton Rogers Mfg. Co., 4 pp, ill, No. 242. Describes this company's facilities for low cost production of molded plastics in small lots. Gives costs of sample products. (24)

Glass Products. Dunbar Glass Corp., 4 pp, ill. Descriptions of this firm's various industrial glasses. Explains advantages of glass to the designer and gives physical properties. (25)

Neoprene. E. I. du Pont de Nemours & Co., (Inc.), 8 pp, ill, No. 44. Includes technical articles on neoprene's use as a vulcanized protective covering, its low hysteresis, and other data of interest. (26)

Plastics Parts. The Fabri-Form Co., 12 pp, ill. Describes numerous sample parts custom-made of thermoplastic and thermosetting plastics, advantages of plastics, and fabricating facilities. (27)

Flexible Tubing. Flexible Tubing Corp., 8 pp, ill, No. 5-4. Applications and performance data on Spiratube flexible tubing for ventilation and materials conveying. (28)

Plastics Compounds. General Electric Co., Chemical Dept., 6 pp, No. CDC-154-1. Properties and advantages of Hycar-phenolic compounds, designed for such properties as moldability and shock resistance. (29)

Rubber-Cushioned Parts. General Tire & Rubber Co., 12 pp, ill. Describes General Silentbloc method of mounting, coupling or isolating moving machinery on rubber. Shows standard parts and specifications. (30)

Plastic-Faced Plywood. Georgia-Pacific Plywood & Lumber Co., 4 pp, ill. Applications, properties and description of GPX high grade exterior plywood coated with plastic. (31)

Rubber. B. F. Goodrich Chemical Co. Properties and applications of Hycar, high strength compression and heat resistant rubber suited to heavy duty service. (32)

Cellular Rubber Parts. Great American Industries, Inc., Rubatex Div., 12 pp, ill, No. RBS. Describes properties, uses and advantages of Rubatex closed cell rubber and facilities for making odd shapes to order. (33)

Plastics. Hercules Powder Co., 4 pp, ill, No. CP51-4. Bulletin describes properties of acetates which make them good materials for toy manufacture. (34)

Thermosetting Resins. Houghton Labora-

MANUFACTURERS' LITERATURE

tories, Inc. Bulletin describes Hysol 6000 Series of plastics said to combine exceptional electrical properties with superior mechanical properties. (35)

Insulating Sheet. Laminated Plastics, Inc., ill. Property data and comparison charts on Glastic MM, Fiberglas reinforced laminate with high strength and heat resistance for electrical insulation. (36)

Apparatus Porcelain. Locke Insulator, Inc., 12 pp, ill, No. 518. Discusses characteristics and limitations of ceramic processes as an aid to designing porcelain apparatus. (37)

Plastics Tubing. Elmer E. Mills Plastics, Inc., 8 pp, ill. Describes this company's plastic tubing, piping and fittings, including some fabricating data and detailed corrosion information. (38)

Nonmetallic Pipe. National Carbon Div., 16 pp, ill, No. CP-2212. Chemical resistance, properties and specifications of pipe and fittings of Karbate, phenolic impregnated carbon and graphite. (39)

Molded Rubber Products. Quaker Rubber Corp., 2 pp, ill. Shows examples of molded rubber products this company is able to produce to specification, among other rubber products. (40)

Fibrous Sheet Materials. Rogers Corp., 19 pp, ill. Data sheets on Rogers Duroids giving properties, test values and applications of each particular Duroid. (41)

Plexiglas for Glazing. Rohm & Haas Co. Booklet gives details on applications, workability and economies of Plexiglas for glazing purposes in factories, housing and hotels. (42)

Package Cushioning. The Sponge Rubber Products Co. Guide helps choose the proper packaging material to meet such problems as shock, corrosion, fungus attack, moisture and temperature. (43)

Electronic Components. Stackpole Carbon Co., 42 pp, ill, No. RC-8. Catalog shows complete line of this company's electronic components. Includes helpful engineering data. (44)

Rubber Parts. Stalwart Rubber Co., 16 pp, ill, No. 51SR-1. Describes this company's weather resistant parts for application in aircraft, trucks, marine equipment and the like. (45)

Ceramics. Stupakoff Ceramic & Mfg. Co., 4 pp, No. 849. Properties of Stupalith, new ceramic said to be unsurpassed in thermal shock resistance. (46)

Ceramic Laboratory Ware. The Thermal Syndicate, Ltd. Technical descriptions, specifications and prices of Vitreosil ware said to be superior to porcelain in some uses. (47)

Plastics Parts. U. S. Gasket Co., 48 pp, ill. Catalog describes properties and uses of Teflon, this company's various Teflon products and also gaskets of various materials. (48)

Polyvinyl Resins. U. S. Rubber Co., Naugatuck Chemical Div., 20 pp, ill. Properties, ingredients, compounding and processing of Marvinol polyvinyl chlorides resins. (49)

Plastics Parts. Watertown Mfg. Co., 44 pp, ill. Complete data on properties and applications of plastics produced by this company. (50)

Felt. Western Felt Works, 32 pp, ill. History of manufacture and uses of felt, including brief description of present-day methods and applications. (51)

Nonmetallic Gears. Westinghouse Electric Corp., 15 pp, ill, No. B-4661. Description and applications of Micarta gears. Includes tables of properties, gear data and preferred pitches. (52)

Metal Parts • Forms

Precision Castings. The Adapti Co., Investment Casting Div. Brochure explains precision casting methods and shows by numerous applications how they are used. (53)

Aluminum Extrusions. Aluminum Co. of America. Design potentials of extrusion process and cost savings in fabrication and assembly of extrusions explained. (54)

Plated Metal Parts. American Nickeloid Co., ill. Indicates wide variety of economies available to users of preplated metals for parts manufacture. (55)

Stainless Steel Parts. Amplex Mfg. Co., 1 p, ill. Information on bearings, finished machine parts and permanent filters made from Oilite stainless steel. (56)

Welded Steel Tubing. Armco Steel Corp., 14 pp, ill. Description, uses, specifications, fabricating information and aids for ordering this firm's welded stainless steel tubing. (57)

Precision Castings. Austenal Laboratories, Inc., Microcast Div., 16 pp, ill. Describes Microcast Process for manufacture of precision cast parts, including specifications and explanation. (58)

Small Tubular Parts. The Bead Chain Mfg. Co. Describes Multi-Swage Process for economically custom producing small mechanical parts up to ¼-in. dia and 2-in. length. (59)

Magnesium Parts. Brooks & Perkins, Inc. Characteristics of, and design data on magnesium alloys. Shows examples of made-to-order parts produced. (60)

Stainless Pipe. The Carpenter Steel Co., Alloy Tube Div. Technical data on Schedule 5 light weight stainless pipe, including discussion of advantages obtained by its use. (61)

Forged Parts. Drop Forging Assn., 60 pp. "Metal Quality" gives detailed data on the effects of hot working metals, describing properties obtained, advantages and limitations. (62)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pp, ill., No. 108. Describes Graphalloy grades for bushings and electrical uses. Bearing design data included. (63)

Investment Castings. Haynes Stellite Co. "Design Factors in Investment Casting" gives information on designing parts for investment casting. (64)

Precision Investment Castings. Hitchener Mfg. Co., Inc., 6 pp, ill. Evaluates precision investment casting methods as to costs, production and properties of parts. (65)

Die Castings. The Hoover Co., Die Castings Div. Describes die casting, gives essential design data including draft, tolerance and wall thickness and core size requirements. (66)

Beryllium Copper Springs. Instrument Specialties Co., 12 pp, ill, No. 6. Catalog shows typical properties and application of beryllium copper springs and electrical contacts. (67)

Precision Die Castings. The Jelrus Co., Inc., 4 pp, ill. Illustrates cost savings in parts production through use of nonferrous precision die casting methods. (68)

Cemented Carbide Parts. Kennametal Inc., 72 pp, ill, No. 51. Characteristics of Kennametal compositions, design suggestions for their use, and descriptions of numerous standard parts. (69)

Pressed Parts. Lenape Hydraulic Pressing and Forging Co. Catalog shows numerous parts press formed by this company illustrating the kinds of jobs this firm can perform. (70)

Die Castings. Madison-Kipp Corp., 32 pp, ill. Describes company's aluminum and zinc die castings. Also shows Kipp Feather-Weight air grinder and Fresh Oil lubricators. (71)

Gray Iron Castings. Meehanite Metal Corp., 8 pp, ill, No. 31. Engineering data on casting plus specific applications showing capabilities of Meehanite gray iron castings. (72)

Investment Castings. Microcast Div., Austenal Laboratories, Inc., 2 pp, ill. Shows typical parts cast from high-temperature, difficult-to-machine alloys. (73)

Forged Brass Parts. Mueller Brass Co., 5 pp, ill. Lower cost, better machinability are among advantages stated for forgings over sand castings used for hardware. (74)

Nonferrous Powder Parts. The New Jersey Zinc Co. "Applications and Properties of Nonferrous Powder Parts" includes 14 case histories indicating cost savings in manufacture of brass powder parts. (75)

Precious Metal Wire. The J. M. Ney Co., 2 pp. Technical data sheets on advantages of using Ney-Oro 6 precious metal wire for pivots in instrument bearings. (76)

Precision Casting. Ohio Precision Castings, Inc., 12 pp, ill. Numerous examples of industrial applications of this company's brass, bronze, aluminum and beryllium copper plaster mold castings. (77)

Seamless Tubing. The Ohio Seamless Tube Co., 12 pp, ill. Shows differences between such tubings as mechanical seamless, aircraft seamless, resistance welded and forged, listing advantages and applications. (78)

Copper Tubing. Penn Brass & Copper Co., 6 pp, ill. Features of this company's seamless copper tubing. Includes tables of safe internal working pressures of various tubing sizes. (79)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp, ill. Describes Phoenixspun method for spinning spherical and extra deep-drawn contours. (80)

MANUFACTURERS' LITERATURE

Metal Powders. Plastic Metals Div., 4 pp, ill, No. 567. Describes applications, advantages and limitations of powder metallurgy as used by this firm for custom-making parts. (81)

Aluminum Extruded Shapes. Reynolds Metals Co., Aluminum Div., 4 pp, ill. Advantages, length classifications and alloys and tempers of aluminum extrusions. Includes tolerances and mechanical properties. (82)

Wire Screens. John A. Roebling's Sons Co., Woven Wire Fabrics Div., 12 pp, ill. No. W-903. Specifications of company's standard screens for grading uniformly and long life. (83)

Stainless Steel Parts. Schnitzer Alloy Products Co., 64 pp, ill, No. 52. Catalog of specifications and prices of wide line of stainless parts, including fittings, fasteners, tubing and tools. (84)

Stainless Steel Castings. The Stainless Foundry & Engineering Co., 4 pp, ill. Shows variety of stainless castings, and includes helpful engineering data. (85)

Spun Metal Parts. Roland Teiner Co., Inc., 4 pp, ill. Describes facilities for spinning metal parts from all types of metal, including stainless steels. (86)

Brass and Bronze Parts. Titan Metal Mfg. Co., 8 pp, ill. Describes this company's facilities for producing high quality brass mill products, including forgings and die castings. (87)

Compression-Formed Tubing. Tube Reducing Corp., 8 pp, ill, No. R-3. Specifications, description and method of making steel compression-formed tubing described. (88)

Centrifugal Cast Parts. U. S. Pipe and Foundry Co., 12 pp, ill. Describes centrifugal casting process and advantages, and shows three applications improved by this method. (89)

Coatings • Finishes

Surface Coating Resins. American Cyanamid Co. Properties, compatability and drying schedules of alkyd, formaldehyde, phenolic and dibasic acid resins for use on surface coatings. (90)

Protective Coatings. R. M. Hollingshead Corp., ill. Folder describes Klad Kote corrosion preventatives, gives detailed specifications, uses, description and other data in tabular form. (91)

Protective Coating. Maas & Waldstein Co., No. 117. Technical data on Water Dip #33, protective coating for plated metal surfaces said to afford good oxidation, protection. (92)

Metallizing Process. The Metallizing Engineering Co., Inc., 4 pp, ill, No. 45A. Case histories showing improvements imparted by Metcolizing processes. Includes description of three processes. (93)

Silicone-Base Finish. Midland Industrial Finishes Co. Brochure describes silicone-base finish said to resist heat of 500 F without discoloration. (94)

Phosphate Coating. Neilson Chemical Co., No. 48-91. Describes Prep-N-Cote, economical phosphate coating for improving corrosion resistance of steel and aluminum surfaces to be painted. (95)

Zinc Dust Paints. New Jersey Zinc Co., 36 pp, ill. Characteristics and uses of zinc dust paints, most adherent painted for galvanized iron and steel zinc. (96)

Protective Coating. Nox-Rust Chemical Corp., 4 pp, ill. Describes Nox-Rust 310-AC protective coating for metal parts. Easily applied, said to afford good protection up to 90 days. (97)

Coating for Aluminum. Parker Rust-Proof Co., 7 pp, ill. Detailed technical data on the phosphate coating of aluminum and test results indicating its effectiveness. (98)

Industrial Protective Coatings. United Chromium, Inc., 4 pp, ill, No. MC-2. Describes Ucilore industrial coatings for corrosion protection of wood, metal and concrete. (99)

Methods and Equipment

Heat Treating • Heating

Salt Bath Furnaces. Ajax Electric Co., Inc., 4 pp, ill, No. 123. Features and advantages of this firm's submerged electrode salt bath furnaces for heat treating. (100)

Continuous Quenching Tanks. American Gas Furnace Co., 4 pp, ill, No. 820. Specifications of complete line of continuous automatic quenching tanks. Shows several factory installations. (101)

Electric Tube Furnace. Harper Electric Furnace Corp., 1 p, ill, No. 1148. Describes small, high temperature electric tube furnace for heat treating operations up to 3000 F. (102)

Heat Treating Furnaces. Holcroft & Co., 4 pp, ill. Features of batch-type controlled atmosphere furnace shown, including automatic cycle and unit-type construction. (103)

Salt Baths. E. F. Houghton & Co., 32 pp, ill, No. 2-363-C. Properties and features of company's various salt baths indicating wide variety of heat treating applications. (104)

Inert Gas Generators. C. M. Kemp Mfg. Co., No. I-10. Specifications, features and applications of this company's inert gas producers. (105)

Induction Heating. The Ohio Crankshaft Co. Describes plant survey and possible applications to which induction heating might be put for greater production economy. (106)

Heat Treating Accessories. Rolock, Inc., 4 pp, ill, No. 949. Describes use of heat and corrosion resistant alloys in baskets, racks, muffles, retorts, trays, etc. (107)

Heat Treating Furnaces. Surface Combustion Corp., 4 pp, ill, No. SC-146. Describes cycle annealing procedure and the advantages attainable using atmosphere type and direct fired furnaces. (108)

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Metal Cleaner. The Diversey Corp., 4 pp, ill, No. 49A. Advantages of Diversey No. 909 heavy duty soak tank cleaner, said to be non-caustic, yet exceptionally powerful. (112)

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Power Driven Brushes. The Fuller Brush Co., 32 pp, ill. Describes Fullergript brushes, their application to such processes as scrubbing steel sheet and tampico brushing. (114)

Finishing Equipment. The Murray-Way Corp. Catalog describes full line of this firm's automatic polishing, buffing and grinding equipment. (115)

Blast Cleaning. Pangborn Corp., No. 214. Details on Rotoblast process for blast cleaning metal parts. Shows typical installations, gives specifications and points out economies. (116)

Finishing Machines. Tumb-L-Matic, Inc. Bulletins describe Tumb-L-Matic finishing machines, their uses and advantages for defining, cutting, smoothing and polishing. (117)

Hard Chrome Plating Unit. Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chrome plating unit, description of process and Chromasol solution. (118)

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Silver Brazing Alloy. American Platinum Works. Physical characteristics and uses of A.P.W. No. 355 silver brazing alloy, closely matching stainless steel in color. (119)

Low Hydrogen Electrodes. Arcos Corp., 8 pp. Question and answer description of low-hydrogen electrodes for welding high tensile steels. Lists electrodes, coating types and uses. (120)

Fasteners. Blake & Johnson Co. Catalog on slotted or Phillips head screws, stove bolts, nuts, rivets, chaplets, special headed products and wire forms. (121)

Rivets. Cherry Rivet Co., Div. of Townsend Co., 8 pp, ill, No. C51. Descriptions and specifications of this company's rivets and rivet guns, information for ordering, and various applications. (122)

Hardfacing Alloys. Coast Metals, Inc., 12 pp, ill, No. G-1001-R4. Advantages, methods of application, properties and uses of hardfacing alloys. (123)

Welding Positioners. Cullen-Friestadt Co., ill. Catalog shows line of hand or power operated welding positioners with capacities up to 30,000 lb. (124)

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Bronze Welding Rod. Eutectic Welding Alloys Corp., No. 443 P. Complete specifications and data on EutecRod 148FC, new bronze welding rod for cast and malleable iron welding. (126)

Brazing Alloys. Handy & Harman, 4 pp, ill, No. 54. Shows several applications of preformed Easy-Flo and Sil-Fos brazing alloys said to enable considerable increases in production. (127)

Cold Headed Fasteners. John Hassall, Inc., 34 pp, ill, No. 60. Explains cost savings available through use of cold headed fasteners. Shows complete line of nails, rivets, screws and other fasteners. (128)

Brass and Bronze Fasteners. The Jaques Co., 26 pp, ill, No. 50. Price lists and specifications of this firm's fasteners, including various nuts, cap screws, bolts and washers. (129)

Induction Heating for Brazing. Lepel High Frequency Laboratories, Inc., 8 pp, ill. Details on induction heating units for accelerated brazing of parts. (130)

Mild Steel Electrodes. The McKay Co., 20 pp. Complete catalog of shielded-arc electrodes for welding mild steels. Also stainless and other special electrodes. (131)

Arc Welding Machines. Miller Electric Mfg. Co. Complete line of a.c. arc welding machines said to be adapted to all applications of "Heliarc" process. (132)

Spot Welding Control. Reynolds Metals Co., 4 pp, ill, No. 15. *Reynolds Metals Technical Advisor* describes new "slope control" said to lengthen tip life and improve weld quality when spot welding aluminum. (133)

Fasteners. Shakeproof Inc., 24 pp, ill, No. AS-42. Booklet shows numerous types of this company's fasteners so arranged as to help the designer choose the best fastener for his job. (134)

Self-Locking Nuts. Standard Pressed Steel Co., ill. Features and applications of Flexloc locknuts, listing prices and specifications of popular sizes. (135)

Special Fasteners. Tinnerman Products, Inc., No. 500. Catalog gives specifications for all of this firm's aircraft fasteners produced under Mil-N-3337 specifications, applications, and describes development. (136)

Weldments. The Van Dorn Iron Works Co., ill. Information on advantages of weldments and this company's facilities for producing them. (137)

Welding Controls. Westinghouse Electric Corp., No. B-4309. Features of this company's welding control and data on accessories which can be added to accommodate production changes. (138)

Forming • Casting • Molding • Machining

Metal Fabrication. Graver Tank & Mfg. Co., Inc., 4 pp, ill. Facilities provided by this firm for designing and producing metal parts of stainless steel, nickel, aluminum and other metals. (139)

Hydraulic Presses. The Hydraulic Press Mfg. Co., 12 pp, ill, No. 5005. Comprehensive catalog describes hydraulic presses for deep drawing, coining, shell nosing and other operations. (140)

Tungsten Carbide Rolls. Metal Carbides Corp., 16 pp, No. CR-50. Manual gives

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Wire Straightening Machine. Mettler Machine Tool Inc., 4 pp, ill. Operating instructions for, and advantages of five types of Shuster wire straightening and cutting machines. (142)

Fabricating Equipment. F. J. Stokes Machine Co., 4 pp, ill, Vol. 4, No. 1. *Stokes News* describes expanded facilities to meet wartime needs for equipment such as plastics molding presses and powder metal presses. (143)

Drilling Machine. Wales-Strippit Corp., 8 pp, ill, No. DM. Describes features, setting up, operation and accessories of Wales drilling machine, designed for precision location of holes. (144)

Metal Forming Facilities. R. D. Werner Co., 4 pp, ill. Explains relative merits of cold roll forming and extruding light metal shapes. Shows company's facilities for both types of fabrication. (145)

Adjustable Perforating Dies. S. B. Whistler & Sons, Inc. Catalog describes this company's line of adjustable perforating dies for punching holes in sheet metals. Includes prices and applications. (146)

Inspection • Testing • Control

Hardness Tester. Ames Precision Machine Works, 6 pp, ill. Describes portable precision hardness tester Model 4 for testing rounds and flats up to 4 in. (147)

Weathering Devices. Atlas Electric Devices Co., 28 pp, ill, No. WO-246-T. Principles and uses of and operation procedures for Weather-Ometer, artificial weathering machine. (148)

Contour Measuring Projector. Bausch & Lomb Optical Co., No. D-27. Specifications and features of contour measuring projector claimed to enable very accurate measurements of parts. (149)

Metallograph. Bausch & Lomb Optical Co., 20 pp, ill, No. E-232. Features of Balphot metallograph for microscopic examination of metallurgical specimens. (150)

Diamond Abrasives. Buehler Ltd., 4 pp. Describes advantages of using Diamet-Hyprez diamond abrasives for polishing metallurgical specimens. (151)

Industrial Radiography. Eldorado Mining & Refining (1944) Ltd., Dept. W. Up-to-date information on nondestructive testing of metals by gamma radiography. (152)

Thermometers. The Electric Auto-Lite Co., Instrument and Gauge Div., 8 pp, ill. Specifications, features and standard dial ranges of this firm's indicating thermometers. (153)

Flow Control Valves. Hauck Mfg. Co., 4 pp, ill, No. 704 A. Describes Micro-Cam oil valves for metering oil flow to industrial heating equipment; includes specifications. (154)

Universal Testing Machines. National Forge & Ordnance Co., Testing Machine Div., No. 501. Specifications, capacities and operating principle of table model universal testing machines. (155)

Portable Hardness Tester. Newage International, Inc., No. ET209. Describes Ernst portable hardness tester for rapid, direct hardness readings in Brinell and Rockwell scales. (156)

Testing Machines. Tinius Olsen Testing Machine Co., 8 pp, ill, No. 40. Describes new line of hydraulic testing machines for tension, compression, transverse and flexure testing. (157)

Radiation Pyrometer. The Pyrometer Instrument Co., No. 100. Features and principle of Pyroradiation pyrometer for obtaining spot temperatures in furnaces, kilns, forgings and fire boxes. (158)

Radiography. The Radium Chemical Co., Inc., 48 pp, ill. Details of radium radiography explaining the nature of the equipment and method, recommended techniques and aids to interpreting results. (159)

Tensile Testing Machines. Scott Testers, Inc., 6 pp, ill, No. 50. Shows wide assortment of testing machines for testing tensile strength of materials such as rubber, paper, wire and thread. (160)

Proving Rings. Steel City Testing Machines, Inc., 2 pp, ill. Description and specifications of direct reading proving rings for calibrating the load on various testing machines. (161)

Moisture Meter. Tagliabue Instruments Div., 4 pp, ill, No. 1263 A. Applications and features of Tag Dielectric Moisture Meter for measuring moisture content of materials such as plastics. (162)

Testing Paints, Coatings. U. S. Testing Co., Inc. Price list for all tests performed by this company on paints and other coating materials. (163)

General

Aluminum By-Products. Aluminum Co. of America, 4 pp, ill, No. AD-251. Describes company's research facilities and their part in the development of ceramic and gallium by-products. (164)

Molybdenum Disulfide Lubricant. Climax Molybdenum Co., 55 pp, ill. Excerpts from technical papers on molybdenum disulfide as a lubricant under various circumstances. (165)

High Vacuum Pumps. Distillation Products Industries. Data on high vacuum pumps of unique design for such uses as metal processing and dehydration. (166)

Labelling Tape. Labelon Tape Co., ill, No. 6. Folder describes features of adhesive tape for identifying equipment. (167)

Materials Controls. Remington Rand Inc., No. KD367. Booklet describes Kardex system for keeping visible materials and parts inventories coordinated with production. (168)

Foundry Blowers. The Spencer Turbine Co., No. 112. Bulletin describes use of Spencer Turbos as blowers for foundries, giving blower features and advantages. (169)

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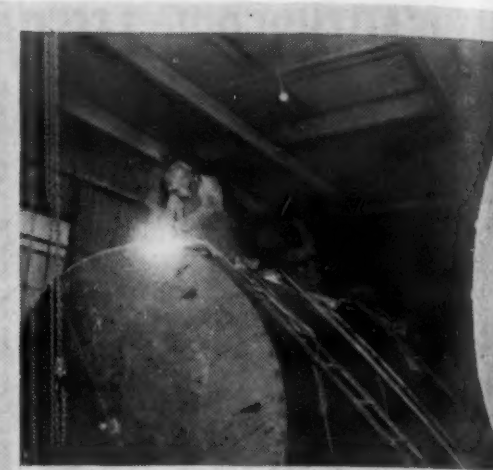

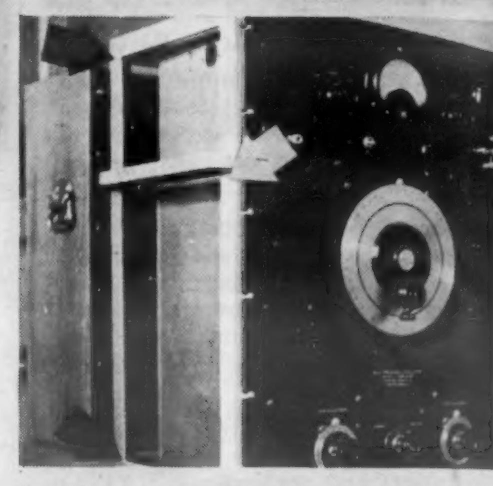

News Digest

elected chairman of the executive committee, combining that office with his position as president of the company. Also announced by the company was the election of *Robert H. R. Loughborough* as a member of the board of directors.

News of Companies

To consolidate and house existing branches of the company scattered in and about the New York metropolitan area, including the general and executive offices, and the new Eutectic Welding Institute (an advanced brazing center for welders), a new, modern Administration Building has been constructed by *Eutectic Welding Alloys Corp.* at Flushing, N. Y.

A total of 20 *Eastman Kodak Co.* fellowships for advanced studies in chemistry, physics and chemical engineering have been offered to U. S. educational institutions for the year 1951-52. The fellowships are for doctoral work, and each provides a stipend of $1200 for one year, in addition to payment of tuition and fees. Selection of the student is made by the university where the fellowship is awarded.

An additional scholarship at Pennsylvania State College for the son or daughter of a company employee has been announced by *Heppenstall Co.* This will be the second, 4-year scholarship valued at $3000, established in memory of C. W. Heppenstall, Sr., who attended Penn State between 1891-1893.

Facilities for the molding and extruding of *General Electric* silicone rubber parts have been transferred from the company's Chemical Dept. plant in Pittsfield to the Decatur, Ill. plant. The centralizing of the rubber fabricating operation is designed to permit better service to the aircraft, automotive and electrical industry, it was stated by G-E officials. Plans to lease manufacturing space in Ludlow, Vt., as part of its currently expanded jet-engine production program, has also been announced by the company. A major addition to G--E's Schenectady turbine plant to be built by the company in a move aimed at boosting the factory's annual output of fuel-fired generating capacity by more than 1,250,000 kilowatts is another result of the expansion program.

Ryan Aeronautical Co. has started construction of a 75,000 sq ft addition to its manufacturing facilities. The new $300,000 building will provide needed production space for further expansion of the company's jet engine components manufacturing program.

Announcement has been made of the

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formation of the *Santa Anita Companies, Inc.*, for the purpose of merging two well-known southern California firms: *Juel Corp.* and the *Calresin Corp.* Kenneth C. Kingsley, former vice president of Norris Stamping and Manufacturing Co. and director of the Thermador Corp., will be president of the new corporation, in addition to retaining his position as president of Juel Corp. William Lockwood, president of Calresin Corp., will become vice president in charge of research.

In line with its new expansion program, the *Dow Furnace Co.* has purchased and is occupying a new factory and office building at 12045 Woodbine Ave., Detroit.

Canadian Industries Ltd. has reported they will erect a new plant at Copper Cliff, Ont. to produce liquid sulfur dioxide from by-product gases arising from the operation of the oxygen smelting process recently developed by *The International Nickel Co., Inc.* It is expected that the new plant will produce 90,000 tons of liquid sulfur dioxide per year.

An intensive program for meeting increasing defense requirements has been set up by the Philadelphia Industrial Div., *Minneapolis-Honeywell Regulator Co.* The plan includes coordinating and expediting of engineering, production and delivery of highly sensitive industrial instruments.

United Engineering and Foundry Co. has received a certificate of cooperation from the Economic Cooperation administration for furnishing technical assistance to the peoples of the Marshall Plan countries.

To increase its defense production, *National Malleable and Steel Castings Co.* has inaugurated a $6,300,000 expansion program which is expected to raise capacity by about 25%, with the larger part of the increase being in malleable iron. All of the company's plants at Cleveland, Chicago, Indianapolis, Sharon and Melrose Park will share in the improvements.

Morningstar Nicol, Inc. has announced that May 1 officially opened its hundreth anniversary of the founding of the company.

Link-Belt Co. has announced the construction of a modern engineering and manufacturing plant for the production of elevating, conveying and processing machinery, on a 43-acre site at Colmar, Montgomery County, Pa.

Inauguration ceremonies for a new research and administrative building and headquarters of Eutectic Welding Institute were recently held in Flushing, N. Y.

A new $3,500,000 silica plant to be constructed at Downington, Pa. has been announced by *Harbison-Walker Refractories Co.* as part of their 22 million dollar expansion program.

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Centric Clutch Co. has announced the occupancy of its newly completed building at the junction of Main St. and Rt. 35, Woodbridge, N. J. The new plant is a one-story, modern structure with about 10,000 sq ft of floor space, a four-fold increase over previous facilities.

All-State Welding Alloys, Inc. has announced construction of a new industrial building adjoining the home office. The structure is expected to double the company's factory area and to provide expanded laboratory and engineering facilities.

Binks Manufacturing Co. has reported the addition of a new Pump Div. to existing departments. The Division, which will deal primarily with material handling pumps, is expected to enable the company to offer customers a more complete line from one source.

A 20-acre tract of land near Warren, Ohio has been purchased by *General Refractories Co.* for the site of their new $3,000,000 silica refractories manufacturing plant.

Cherry Rivet Co., a division of *Townsend Co.,* has recently announced the acquisition of a 10-acre tract in the Bassett area, east of Long Island, where they will immediately begin construction of a new manufacturing plant.

Plans to construct a formaldehyde and liquid urea resin manufacturing plant on the outskirts of Demopolis, Ala., were announced by *Borden Co.* This will be the first plant in the Southeast to produce formaldehyde.

News of Societies

At the annual meeting of the Nominating Committee, the *American Society for Metals* named the following men to serve as officials for the 1951-52 term: Dr. John Chipman, Head, Dept. of Metallurgy, Massachusetts Institute of Technology, president; Ralph L. Wilson, director of Metallurgy, Timken Steel and Tubes Div., Timken Roller Bearing Co., vice president; Ralph L. Dowdell, head, Dept. of Metallurgy, University of Minnesota, treasurer.

Gordon Brown, vice president of the Bakelite Co., division of Union Carbide and Carbon Corp., was elected president of *The Societty of the Plastics Industry, Inc.* at SPI's annual conference held at the Greenbrier Hotel, White Sulphur Springs, W. Va. Other officers elected for the coming year were as follows: Horace Gooch, Jr., Worchester Moulded Plastics Co., chairman of the board; Dale

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Amos, Amos Molded Plastics, vice president; and J. E. Gould, Detroit Macoid Corp., secretary-treasurer.

Henry M. Richardson, DeBell & Richardson, chairman of the *Society of Plastics Engineer's* prize paper contest, has announced that Carl J. Frosch of Bell Telephone Laboratories will serve as chief judge in the third annual contest for which entries are now being received. The contest is designed to encourage the younger members of the Society in the preparation of technical papers contributing to the advancement of the plastics industry.

The appointment of Dr. Egon Orowan as George Westinghouse professor of mechanical engineering at the *Massachusetts Institute of Technology* was recently announced by the dean of engineering. Dr. Orowan succeeds Professor William R. Hawthorne, who has held the Westinghouse chair since 1948.

American Standards Association has announced awards to members of its board of directors and standards council who have served more than a year. Certificates of service given in recognition of their work in the development of American Standards were given to the following men: Maurice Stanley, chairman of the board, Fafnir Bearing Co., representing the Anti-Friction Bearing Manufacturers Assn. on ASA's board of directors; George P. Byrne, Industry Service Bureaus, representing the U. S. Machine, Cap, Wood and Tapping Screw Bureaus; Alton G. Knight, chief engineer, Hendey Machine Co., representing the National Machine Tool Builders' Assn.; Harry B. Lindsay, secretary-treasurer, Grinding Wheel Institute; and H. O. Smith, secretary-manager, The Anti-Friction Bearing Manufacturers Assn.

The promotion of two scientists to head new divisions at *Armour Research Foundation* of *Illinois Institute of Technology* was announced by the Foundation director. Dr. LeVan Griffis, chairman of applied mechanics, was named manager of a new engineering mechanics division, while Dr. E. H. Shulz was appointed manager of a new physics and electrical division. The Foundation has also made known the appointment of Dr. Julian Glasser, physical chemist, as technical aide on titanium and zirconium research in a new metallurgical unit of the National Research Council. At the first National Congress of Applied Mechanics, recently held at Illinois Tech, five general lectures and 138 technical papers were presented in 27 sessions on various phases of applied mechanics. Lloyd H. Donnell, research professor of mechanics at Illinois Tech, was general chairman for the meeting.

Formation of a joint committee representing the nation's foundries, scrap

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dealers and steel mills, to deal with the critical scrap problems, was announced by Robert W. Wolcott, chairman, Lukens Steel Co., and chairman of the Committee on Iron and Scrap of the *American Iron and Steel Institute*. The new committee is to be called the Mobilization Committee for Iron and Steel Scrap.

Dr. Frederick D. Rossini, professor and head of the Dept. of Chemistry at *Carnegie Institute of Technology*, has been elected to the National Academy of Scientists. He is one of 29 American scientists recently elected to the group, bringing the total national membership to 481.

The recently organized *National Association of Aluminum Distributors* has announced the appointment of Raymond L. Collier as executive secretary. Mr. Collier has had some 25 years of experience in trade association activities, having served three years with the Lighting Equipment Manufacturers Association, 18 years with the Steel Founders' Society of America, and four years with the Gray Iron Founders Society, Inc.

Watertown Arsenal, Dept. of U. S. Army, has awarded a contract to the Research Div., *New York University of Engineering*, to cover studies on titanium alloyed with the metalloids: carbon, nitrogen oxygen and boron. The work will be under the direction of John P. Nielsen, associate professor of metal science.

The 1951 James Turner Morehead Medal of the *International Acetylene Association* has been awarded posthumously to M. Keith Dunn, late president of National Cylinder Gas Co. The medal is awarded annually by the Association for outstanding work in advancing the industry or the art of producing or utilizing calcium carbide, its derivatives and allied products, the most important of which is the gas, acetylene.

As a result of considerable expansion in the research volume at *Midwest Research Institute*, Dr. C. N. Kimball, president, has announced the appointment of Dr. M. H. Thornton, chairman of the Chemistry Div. and Martin Goland, chairman of the Engineering Div., as associate research directors of the Institute. Dr. Thornton will become associate director for chemistry, coordinating activities in this field; Mr. Goland will be associate director for engineering sciences.

The newly completed Hydrodynamics Laboratory and Ship Model Towing Tank at *Massachusetts Institute of Technology* was recently dedicated at the opening session of a three-day symposium on the role of hydrodynamics in modern technology. More than 300 engineers and scientists attended the session, which commemorated the completion of the first new facilities made possible by the school's recent successful $20,000,000 development program.

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2. Select sub-group which best fits application
3. Note major tool characteristics (under arrow) and other characteristics in cut-outs for each grade in sub-group
4. Select tool steel indicated

That's all there is to it!

Here's an example:

Application—Deep drawing die for steel

Major Class—Metal Forming—Cold

Sub-Group — Special Purpose

Tool Characteristics—Wear Resistance

Tool Steel—Airdi 150

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TOOL STEELS

Meetings and Expositions

American Institute of Electrical Engineers, Pacific general meeting. Portland. Aug. 20-23, 1951.

American Chemical Society, diamond jubilee meeting. New York. Sept. 3-7, 1951.

Society of Automotive Engineers, tractor and production forum. Milwaukee. Sept. 10-13, 1951.

American Society of Mechanical Engineers, Instruments and Regulators Div. and Instrument Society of America, exhibit and joint conference. Houston. Sept. 10-14, 1951.

American Institute of Mining & Metallurgical Engineers, Industrial Minerals Div. fall meeting. Morgantown, W. Va. Sept. 13-15, 1951.

Steel Founders' Society, fall meeting. Hot Springs, Va. Sept. 24-25, 1951.

American Society of Mechanical Engineers, Petroleum Mechanical Engineering conference. Tulsa. Sept. 24-26, 1951.

American Society of Mechanical Engineers, fall meeting. Minneapolis. Sept. 25-28, 1951.

Association of Iron & Steel Engineers, annual convention. Chicago. Oct. 1-4, 1951.

Industrial Packaging & Materials Handling Exposition. Cleveland. Oct. 1-4, 1951.

American Institute of Mining & Metallurgical Engineers, Petroleum Branch fall meeting. Oklahoma City. Oct. 3-5, 1951.

Pressed Metal Institute, annual meeting. Chicago, Oct 3-6, 1951.

Society of Automotive Engineers, aeronautic production forum and display. Los Angeles. Oct. 3-6, 1951.

Electrochemical Society, fall conference. Detroit. Oct. 9-12, 1951.

Porcelain Enamel Institute, annual forum. Columbus. Oct. 10-12, 1951.

American Society of Mechanical Engineers, Fuels and AIME Coal joint conference. Roanoke, Va. Oct. 11-12, 1951.

American Welding Society, annual meeting. Detroit. Oct. 14-20, 1951.

American Gas Association, annual convention. St. Louis. Oct. 15-17, 1951.

American Institute of Mining & Metallurgical Engineers, Institute of Metals Div. fall meeting. Detroit. Oct. 15-17, 1951.

American Society for Metals, annual meeting. Detroit. Oct. 15-19, 1951.

National Metal Congress & Exposition. Detroit. Oct. 15-19, 1951.

NEWS about non-Ferrous metals

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BOOK REVIEWS

Engineering Metals

THE BEHAVIOR OF ENGINEERING METALS. *By H. W. Gillett. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1951. Cloth, 6 by 9¼ in., 395 pages. Price $6.50.*

This volume, which was intended as an aid to non-metallurgists whose work requires them to select metals and alloys for engineering uses, was written by a man who spent a large portion of his life in writing about engineering materials. As a result, the work is both authoritative and easy to read.

Under today's conditions, most people engaged in engineering and designing activities find an almost constant need for information on engineering materials. Dr. Gillett's work seems to be adequate to meet all needs of this nature as far as metals are concerned.

The first six chapters of the book introduce the basic concepts of metallurgy. The terms are introduced in natural sequence, and examples show how they are used.

The next nine chapters deal with the behavior of each of the principal commercial metals and alloys, and the remainder of the book is devoted to special considerations that may influence the selection of metals and alloys. These include such topics as machinability, special fabricating techniques, means of using or selecting metals so as to combat the effects of corrosion, wear and high temperature, and some "tricks of the trade". The vital factors of cost and availability are the subject of the closing chapter.

Sound choices of materials are compromises based on judgment. Quantitative data, and many behaviors not quantitatively expressible, enter into that judgment. It is to help make sound judgments that this book was written.

Other New Books

1950 SUPPLEMENTS TO THE 1949 BOOK OF ASTM STANDARDS. *Published by the American Society for Testing Materials, Philadelphia 3, Pa., 1951. Paper, 2168 pages. Available in six parts—$3.50 per part, or $21.00 for the set of six.* The 1950 Supplements, recently issued in six parts, give in their latest approved form some 353 specifications, tests and definitions which were either issued for the first time in 1950 or revised since their appearance in the 1949 Book. Of particular interest is Part 1 on ferrous metals, Part 2 on nonferrous metals, and Part 6 on electrical insulation, plastics and rubber.

Advertisers and their Agencies

an indispensable reference book for paint users and manufacturers

PAINT FILM DEFECTS
Their Causes and Cure
by Manfred Hess

This remarkably valuable book is the most complete compilation of paint defects and failures in existence. The contents are arranged as a reference work whereby Failure—Cause—Remedy appear under such sections as: Faults which develop during storage; Faults which develop during application; Failures developing shortly after application; and Defects of coatings on the finished objects when in use.

A glance at the 88-page index will impress you with the countless ways by which paintwork or lacquering may be spoiled despite the fact that the work is carried out with great care and skill or with the best materials! Yet there are the cracks, the discoloration, the stickiness, etc., etc. You can never exclude occasional failures, but you can reduce their number by discovering their causes. This book helps you locate the fault, even if due to several reasons, and shows how to correct it.

This first English edition is based on the standard German work but it has been largely rewritten and considerably enlarged. Many new sections connected with paint failures as they occur in typical damp climates, and important developments in the raw material side of the paint and varnish industry, have been added.

This unique book will save much time and money for paint users. It will also be of interest to paint manufacturers.

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The Editor's Page

A Recurring Problem

From time to time we get friendly letters from our readers suggesting changes which they feel would be helpful to them. One of the most frequent ideas is that no two feature articles should be published so that one cannot be torn from the issue without destroying one or the other of them.

We—and the publishers of most other technical magazines—have studied this problem for a long time. To do this might make necessary the injection of advertising into the main editorial section. That answer falls short of perfection for a few reasons, not the least of which is the fact that advertising forms and locations are usually frozen long before the complete needs of the editorial pages have been determined. Consequently, situations would arise where there would be too many or too few advertisements to fill the available space.

In addition, there are probably as many people who prefer a clean, unadulterated editorial section as there are on the other side. So what is an editor to do? This is one situation in which you can't be a mugwump.

We Love 'Em

Lest there may be some present who, after reading the above, think that we editors and our readers don't like advertising, please be reassured. Our readers welcome advertising—particularly that which tells them something useful—as feelingly as do the publishers. It's just that some like them separate. In other words, it's like having your dessert after the meal rather than mixed with the mashed potatoes.

A Good Alibi

We read recently that the editor of a weekly newspaper has stopped worrying about typographical errors since learning about a trick used by some Chinese editors (pre-Red, of course). Some of these clever individuals claimed that they purposely injected typos into their columns because of the lift they gave to the egos of the readers that found them. Even though some readers might sometimes think so, we never have intentionally tried that trick. All of ours are pure, honest slips.

Our Own Medicine

One of our editors, a few weeks ago, had a rare opportunity to use some of the information we hand out so regularly. It so happened that his wife burned some grease into her shiny, new stainless steel (copper-bottomed) frying pan. After some struggling to clean it, the wife sent an S.O.S. to the head of the house. Rather than become indignant, our man calmly grabbed the issue of M&M which carried the manual on "Cleaning and Finishing Stainless Steels". After a few minutes of study he confidently went to work, using his newly-found knowledge, and in a few minutes all was well again. Said editor has new respect for his job, and his co-workers.

History Repeats, Etc.

In the early days of wire drawing, mechanical descaling of the rod (usually by hand scraping) was the only method used or known. As science progressed acid pickling came into vogue, bringing with it many advantages, plus some new problems. One of the problems was acid supply, which led a French mill to try mechanical descaling when they could get no acid during the last war. Soon they eliminated the acid entirely. Now a similar process is being tried here and it seems destined for wide acceptance. Mechanical flexing does the job. The outlook is for the elimination of hydrogen embrittlement when acid is no longer used. So history has just about completed another cycle.

We are indebted for this intelligence to *The Mainspring*, the buoyant magazine published by Associated Spring Corp.

T. C. Du Mond
Editor